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Our July Issue

The four conventions reported in this issue were all so important, from the standpoint of *American Engineer* readers, that we have been compelled to devote a much larger part of the paper to them than was at first expected, and among other things a large number of shop kink and shop practice articles, which were intended for this issue, have had to be held over. To offset this a much larger portion of the July issue will be devoted to these subjects than has been customary.

The June Dailies

American Engineer readers will receive copies of the eight issues of the *Daily Railway Age Gazette,* which is published at Atlantic City, N. J., during the Master Car Builders' and Master Mechanics' conventions, June 12-19. The practice of the *American Engineer* has always been to publish abstracts of the proceedings of these conventions in its July and August issues, but this will be discontinued this year, because of the arrangement whereby its readers will receive a detailed account of the proceedings in the *Daily Railway Age Gazette.* Many of our readers will undoubtedly want to bind the dailies with the *American Engineer* at the end of the year, and our annual index will therefore include all of the articles in the *Daily Railway Age Gazette,* as well as the *American Engineer.*

Reclaiming Scrap Material

This problem came up at the annual meeting of the Railway Storekeepers' Association in two different forms. The committee on recommended practices advocated the installation of a special salvage department which would come under the direct control of the storekeeping, or supply department, and whose duty it would be to gather up all obsolete and scrap material, and arrange for reclaiming or selling it. E. J. McVeigh, a member of the committee, also read an extensive paper, in which he drew attention to the abuses which could be corrected if this matter was placed in the hands of a separate department, instead of being left to several departments or individuals, no one of which was entirely responsible. J. H. Callaghan's paper on Line Inspection also touched on the improvements which could be made in the proper use of materials and the reclaiming of scrap and second-hand material, by having an inspection team of officers make frequent trips over each division. Abstracts of both of these papers, and the discussions on them, will be found in another part of this issue.

The May Conventions

The conventions of the four associations which met in May, and which are reported in this issue, were more than ordinarily successful, both as to attendance and the grade of the papers and the reports which were presented, and the way in which they were discussed. Three of the associations have decided upon the place of meeting for next year, two going to Chicago and one to St. Louis. It is rather significant that all four of the new presidents are from the middle west. H. A. Wahlert, the new president of the Air Brake Association, is with the Texas & Pacific; M. O'Connor, president of the Master Boiler Makers' Association, is with the Chicago & North Western at Missouri Valley, Ia.; J. R. Mulroy, president of the Railway Storekeepers' Association, is with the St. Louis & San Francisco at Springfield, Mo., and H. T. Bentley, president of the International Railway Fuel Association, is with the Chicago & North Western at Chicago. Of the 17 railway men who were elected as officers of these four associations, 14 come from the West and only three from the East. Usually the men selected for positions of this kind are from among those who are most active at the conventions, or who have attracted special attention because of the good work

they have done in the preparation of papers or reports. It is rather strange that more eastern men are not represented on the official boards of these associations.

Shop Practice Competition

A prize of $25 will be awarded for the article, received before September 1, 1912, describing the best practice for repairing pistons, piston rods and crossheads. The description should cover both the renewal and repairs of the following parts: Piston heads, piston packing, piston rod, crosshead, crosshead shoes, wrist pin and slot and key, if the rod and crosshead are secured together in that manner. A time study of each operation, including a brief specification of the machine tool used and the feed and speed at which it is operated, will give the competitor considerable advantage in the decision. The article should be accompanied by a detailed account of the method used in transferring all the different parts from one place to another in the shop and with drawings or photographs showing any new kinks used in connection with the work. Mr. Spidy's article on the repairs to driving boxes in this issue will serve as a model for the kind of an article that should be submitted. Contributions which do not win a prize, if considered of sufficient value for publication, will be paid for at our regular space rates.

Absorbent Towels vs. Waste

Some interesting data concerning the use of absorbent towels for general wiping purposes, was brought out in a paper by W. O. Taylor, of the Galena Signal Oil Company at the Railway Storekeepers' convention at Buffalo, N. Y. This paper appears in abstract in another part of this issue. The oil is extracted from the towels, when they become soiled, by what is known as an emulsion machine, which is of the centrifugal type. On one road the oil thus extracted is sold to the signal department for the lubrication of switches, resulting in a saving of $163.28 each month. This saving takes into account the cost of the towels, as well as the cost of cleaning them. It is expected that with fair usage the life of the towels will be about five or six months. Machines for reclaiming the oil from waste or packing are not in general use, although there would appear to be a good field for them on most roads. The New York Central & Hudson River uses such a machine at its East Buffalo, N. Y., car shop for cleaning journal box packing and soiled waste from the shops. It was described in the Shop Section of the *Railway Age Gazette*, August 5, 1910, page 236.

The Brick Arch

The brick arch committee of the Master Boiler Makers' Association is to be congratulated on the thorough, well-arranged and comprehensive report which it presented at the convention in Pittsburgh. The necessity for increased boiler capacity has done much, on many roads, to bring about a more general introduction of the brick arch, although the fuel savings, which are made possible by its use, are not to be overlooked, as indicated by the report and discussion which appear in abstract elsewhere in this issue. Like any other part of a locomotive, the best results can only be obtained when the arch is properly installed and taken care of. That the brick arch has not proved an entire success in the past has been not because it has not given good results in improving the combustion and preventing smoke, but because of difficulties in maintenance due to improper design and installation. The sectional arch which has been introduced within the past few years has overcome the difficulties which were experienced with the older types of arch, and has made it possible to secure the extremely favorable results which were reported at the meeting of the Boiler Makers' Association.

Repairing Driving Boxes

E. T. Spidy, assistant general foreman, Winnipeg shops, Canadian Pacific, is the winner of the $25 prize in the competition on the methods of repairing driving boxes, which closed May first. Mr. Spidy's article will be found in another part of this issue. In awarding this prize, it is recognized that in some particularls Mr. Spidy's methods are probably not the best and the decision of the judges was based on the complete operation rather than the details. There is evidently a great diversity in ideas of the proper way of repairing driving boxes throughout the country, and it is to be hoped that the articles on this subject, published in this and succeeding issues, will draw attention to more rapid and less expensive ways of performing the ten or twelve necessary operations included in this work. The custom of putting driving boxes in a lye vat, boiling them for about three hours, and afterwards washing and wiping is very general. It has been found at several places that by turning a stream of warm water on the boxes and then wiping with waste, equally satisfactory results are obtained. This takes but about ten minutes per box.

Some roads tap the screw in plugs to hold the brasses. These require drilling before the brasses can be pressed out. A straight taper plug driven from the inside is equally good and does not require the box to be taken to a drill press. The practice of forming the outside of the crown brass by turning it in a lathe, and then transferring it to a shaper or slotter for finishing the corners, is quite general. This requires two settings and two machines. A better method seems to be to lay off the brass with a suitable instrument, and then shape or slot it complete at one setting. A draw-cut shaper fitted with a special appliance is used to advantage in some shops for doing this work. A number of roads are casting the crown brass in place in the box. Where suitably shaped and located dove-tailed grooves are cut and the box is heated sufficiently before pouring, this practice is proving most successful, and of course, from the standpoint of the shop, it is a satisfactory short cut which completely eliminates at least two operations. One company, at least, is using a removable brass held in place by a wedge. From an engine house viewpoint this construction has many advantages, but it makes more expensive work for the shop. Brass liners machined and fitted in the shoe and wedge channel of the box appear to be an unnecessary refinement. It is far better to groove the channel and cast the liner (in some cases made of hard babbitt) in place. There seems to be little doubt but a liner of some kind is a necessity unless bronze shoes and wedges are used.

Practice varies considerably in connection with the hub liner, which is sometimes found on the wheel center, sometimes on the driving box face, and sometimes on both. The best practice appears to be a liner on the driving box face which can be removed and replaced without dropping the wheels. Such liners are in use in a few places. Following this, the liner of hard babbitt cast on the face of the box, the edge of the recess being eccentric with the journal, seems to work very well if the proper quality of babbitt is used. This has the big advantage of not requiring machine work for facing, as the surface when cast against a steel form is sufficiently smooth. Brass is probably the most common material for this purpose, and is often fitted and secured in place with countersunk screws. A better practice, if brass is used, is to cast it in place. From the standpoint of repairs alone, babbitt is preferable, as no machine work is required either for removing or applying it. Furthermore babbitt can be easily melted anywhere, and the forms to cast it are simple.

After all, the shop generally has to accept what is given it to do, and it is probable that the greatest improvement to be made in most shops will be found in the relocation of the tools to give the proper sequence of operations and the fur-

nishing of convenient and ever ready handling appliances. That something along this line can be done in practically every shop, with a considerable reduction in the time of the complete series of operations, is a conclusion drawn from the contributions submitted.

Notes on the Fuel Convention

Papers and reports of a high character, an intelligent, active discussion and a general interest in the proceedings made the recent meeting of the International Railway Fuel association very successful. It is evident that this association has a real object for existing, and that the members propose to make it of as great value as possible both to themselves and the railways. While it is unfortunate that it was necessary for the president to call on members by name for expressions, this is doubtless an objection which will gradually be reduced as the association grows older. A number of members came fully prepared to speak on the subjects of interest to them, and it is to be hoped that this practice will grow more general. It will be necessary, however, for the committees to finish their work and allow the secretary to have the papers printed and sent to the members several weeks before the convention, if fully digested discussions are to be prepared. Some of the older associations should not be taken as a model in this respect.

Moving pictures to demonstrate the results of good and poor firing were unanimously voted a big success. Mr. Buell's paper and pictures were the most impressive features of the convention. Actual demonstration is, beyond doubt, the best method of teaching any form of physical activity and moving pictures which permit such a demonstration to be carefully studied and to be presented anywhere at any time before any sized audience open wonderful possibilities for educational work. It is hard to understand how any fireman who has seen the picture demonstrating the amount of coal lost through an open safety valve, can fail to have this large pile of coal appear in his mind every time the pop opens. Or again, when he sees the difference between the amount of work performed by the good and poor fireman under the same conditions, how he can help but be anxious to learn and practice proper methods. Mr. Buell has developed a method which will probably take its place among the most important agencies for improvement and the Fuel Association is to be congratulated on having its meeting the theater of his first exposition.

Stimulated by Dr. Goss' experimental locomotive with 150 sq. ft. grate area and without a tender, some very fanciful arrangements were suggested. One member drew a picture of a train with a power house on wheels at the head, furnishing electric current to tractor cars located about ten cars apart throughout a train of any imaginary length. While wireless transmission between the source of power and the tractor cars was not mentioned by the speaker, it is probable that this was an oversight. The 6-ft. gage also bobbed up its head again in this connection. The members with good imaginations had a big advantage in the discussion of this subject, and it was unfortunate that the time did not permit all of them to get on record.

T. E. Adams, superintendent of motive power of the St. Louis Southwestern, received a long overdue public recognition and appreciation of the methods of firing he developed and has had in use for a number of years. He described his system in detail before several associations, but the full importance of his work does not seem to have been realized until recently. H. T. Bentley took this occasion to publicly thank Mr. Adams for what he had done and strongly recommended that all the members study the firing practice on the St. Louis Southwestern.

It came as a distinct surprise to most of the members present to discover that it was not infrequent for a locomotive to exert a greater horse power in producing draft than in producing tractive effort. Mr. MacFarland's paper on the subject of locomotive draft contained probably the most valuable information on back pressure that has ever been presented. It was disappointing, however, that the paper did not include definite recommendations as to how to overcome the big losses shown by the tests. The author reported verbally that he was experimenting with induced draft by means of a fan in the front end to take the place of the exhaust pipe, and he had discovered that 50 horse power would be amply sufficient for very large locomotives. He hopes at the next meeting to give positive information as to the success of such an arrangement. The paper was also disappointing, in that there was no data presented as to the air openings in the ashpan, or the amount of vacuum at points other than the front end. Because of this, no opportunity was given to discover what effect the firebox end of the boiler might have had upon the results shown.

It appeared as if some of the railway supply companies had overlooked an excellent opportunity for the demonstration of their wares at this meeting. The exhibits were practically insignificant, although there was sufficient conveniently located space provided for them. The membership of this association is of the class that will well repay any of the supply companies having apparatus in any way connected with the saving of fuel, to go to considerable trouble to reach under such favorable conditions as existed at these meetings. Some firms saw their opportunity, and had exhibits, but they were far too few.

There is no doubt that unless every feature of locomotive and train operation having an effect on the consumption of fuel is known within a reasonable error, an accurate and reliable fuel performance sheet cannot be maintained. If the performance sheet is inaccurate, its value in the form of influence on the engine crews to make greater efforts or to compete one with the other, is practically lost. It would therefore seem, so far as this effect on the engine crew is concerned, that it is practically useless to attempt to maintain these records. As a basis for the proper coal distribution, and for a record of the fuel consumption in different classes of service, they probably have some value. As one member expressed it, "You can tell more about a fireman's work by the length of time it takes to clean the fire he brings in than you can by all the coal chute records it is possible to collect." In this connection it should not be overlooked that the mere knowledge of the presence of a record has a good moral effect, and aside from any other value, this might make a fuel performance sheet worth while.

NEW BOOKS

Treatise on Planers.—Practical information and suggestions for economically producing flat surfaces. 102 pages, 122 illustrations, 6 in. x 9 in. Bound in cloth. Published by the Cincinnati Planer Company, Cincinnati, Ohio. Price, 50 cents.

This volume has been prepared to aid those confronted with the sometimes perplexing problems of producing flat surfaces quickly and accurately. The subject has been treated in a clear and comprehensive manner, carefully avoiding any unnecessary discussion and presenting to apprentices and mechanics many points pertaining to the tools and fixtures used in connection with planer work. The book has been divided into eleven chapters. The first discusses what work should be planed, and included in this is a description of the various types of planers, one illustration being accompanied by a list giving the names of all the parts on a modern planing machine. In the next chapter the tools used are discussed at some length and illustrations are presented showing the proper shapes and manner of setting. Following this are chapters on methods of holding the work, special planer fixtures, samples of practical planer work, spiral, radius and arc planing, as well as the proper methods of taking care of the machine. A separate chapter is devoted to cutting and return speeds, and the volume is completed by a fully illustrated description of the proper way of setting up a new planer.

REPAIRING LOCOMOTIVE DRIVING BOXES

First Prize Article in the Shop Practice Competition. Detailed Description of the Methods Used at the Winnipeg Shops of the Canadian Pacific.

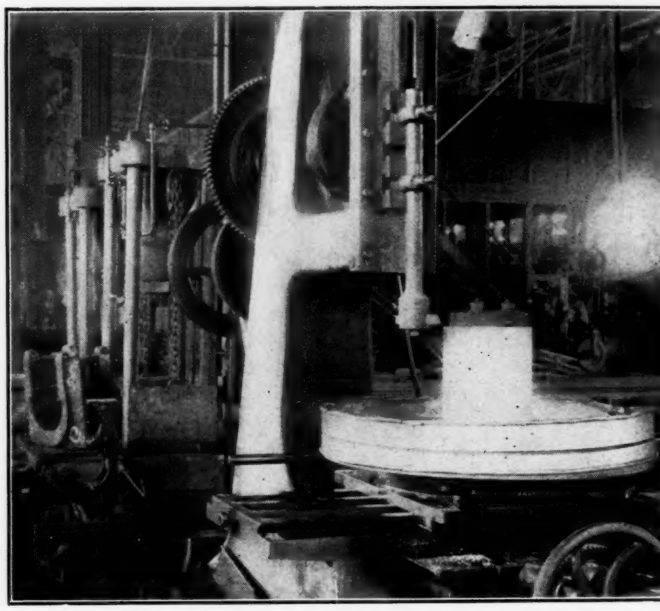
BY E. T. SPIDY.*

When a study is made for the purpose of obtaining the best results, both as to time and cost, in repairing driving boxes, it will be found that there are three fundamental features to be considered. 1. To reduce the time between operations to a minimum; i. e., to give to each man handling facilities and means of transportation independent of the regular shop cranes. 2. To arrange the machines and benches in the correct sequence of operations so that each man will be able to pick up the box with his crane from where it was placed by the last man; also that all the boxes may pass along a definite and direct route. 3. To adopt the most efficient methods of machine operation with the machinery available.

One of the illustrations shows a section of the Winnipeg shops of the Canadian Pacific. An auxiliary crane runway has been erected, extending down the whole length of the section devoted to driving box repairs. One rail is supported on the shop columns and the other on columns 22 ft. apart, made from old superheater flues. On this runway are three travelers, that handle all the work to and from the machines. The pipe columns are also utilized to support the light jib cranes used to lift the boxes from the floor to the bench and to the axles. Back of the benches is a track on which the wheels are placed when being fitted; behind this is a double track for wheel storage.

In describing the system of handling driving boxes in a shop like this one, it must be remembered that all the boxes do not receive identical treatment, because of their being of different designs. For instance, all boxes do not have spring saddle pockets in the top, and thus do not have a pocket to be milled square (see operation No. 7). In such cases the box will pass straight up the line to the machine that is to operate on it. Boxes that do not require new crown brasses may require side liners, but they will all follow the general sequence and finish at the same place.

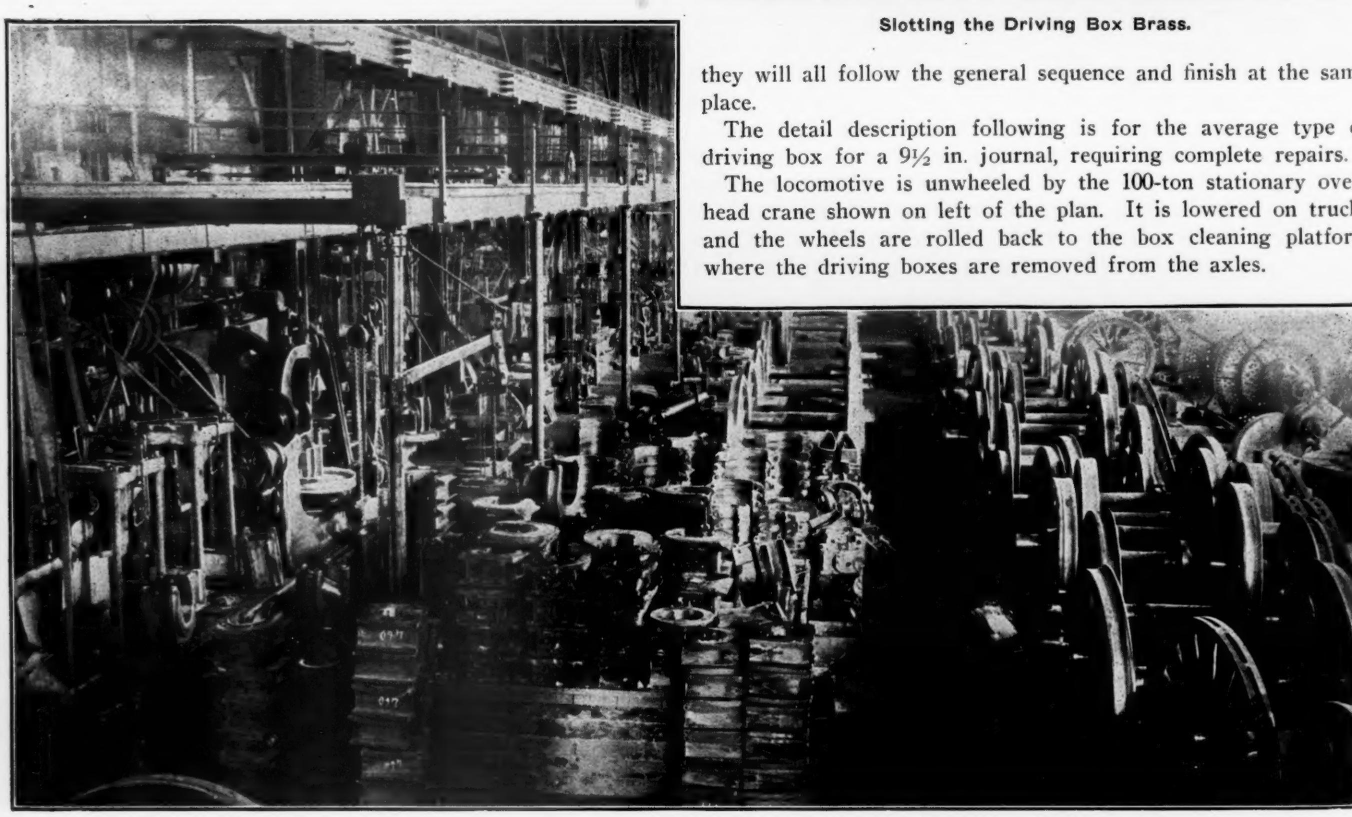
*Assistant general locomotive foreman, Canadian Pacific, Winnipeg, Man.



Slotting the Driving Box Brass.

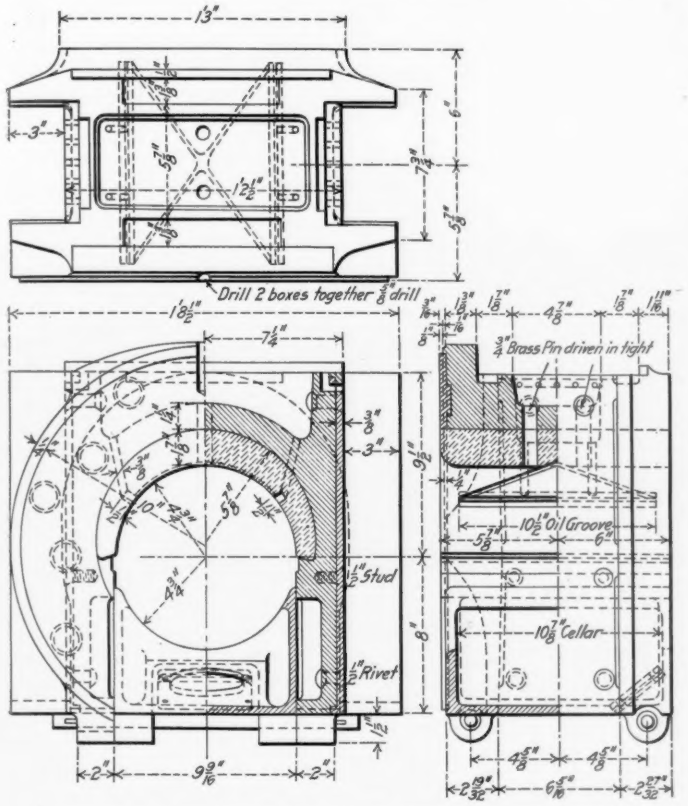
The detail description following is for the average type of driving box for a 9½ in. journal, requiring complete repairs.

The locomotive is unwheeled by the 100-ton stationary overhead crane shown on left of the plan. It is lowered on trucks and the wheels are rolled back to the box cleaning platform where the driving boxes are removed from the axles.



General View of the Driving Box Section of the Winnipeg Shops.

Operation No. 1. Strip boxes from axles.—The cellar pins are driven out and the box, if not tight to the cellar, falls to the ground; if tight, it is driven out with a large hammer, or with a jack. No exact time can be given for this operation, as it varies from five minutes to an hour, according to the difficulty experienced in removing the cellar. An average time for a box lubricated by oil would be about 10 minutes.



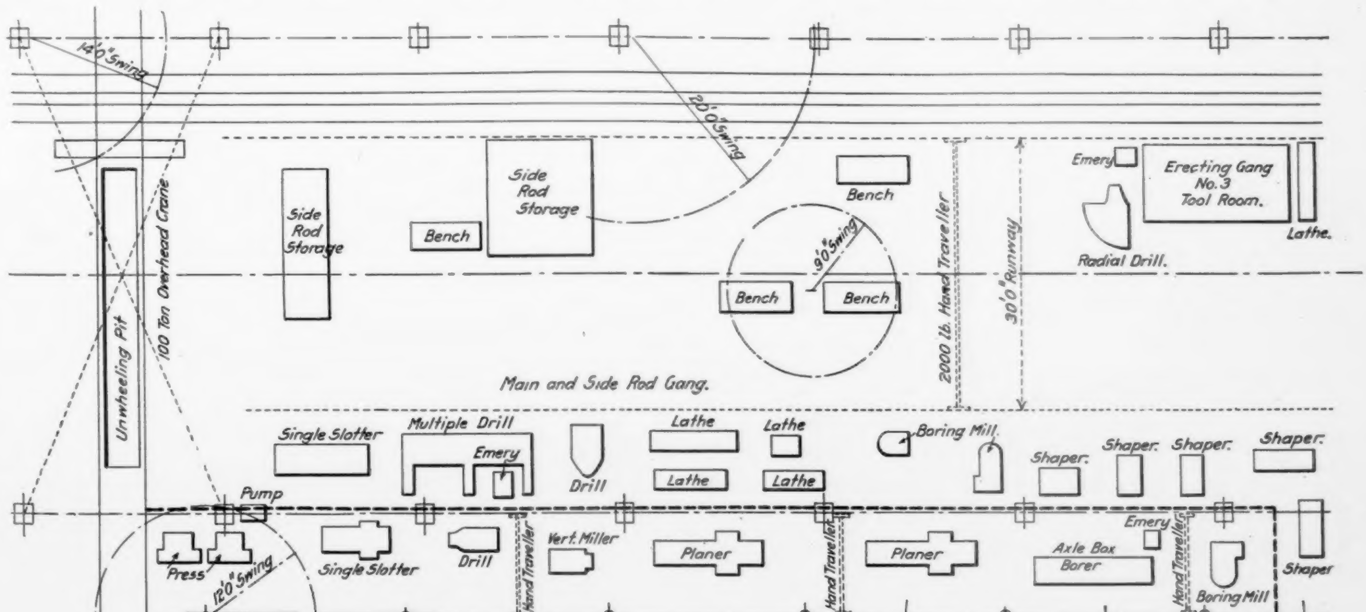
Driving Box on Which the Times Specified Were Obtained.

Operation No. 2. Clean box and cellar.—The boxes are then lifted with the small jib crane on the end post of the runway, to a cleaning platform that is about 30 in. high. Here they are cleaned by hand. A previous method of using a lye vat was discarded on account of the length of time required. The cleaned boxes are placed on the press side of the table, convenient to press operator. The average time for one helper to clean one driving box and cellar, would be 15 minutes for an oil lubricated box and 30 minutes for a grease lubricated box.

Operation No. 3. Strip crown brass and side liners.—The press used to remove crown brasses is of 50 tons capacity, and was made at the shops. Recently it was found necessary to add another press to keep up with the capacity of the rest of the machines. One press now does the stripping, and the other does the pressing in. An assistant to the press operator strips the side liners from the boxes after the removal of the crown brass. The detail operations are as follows:

Place the box in position to drive out the dowels	3 min.
Drive out 2 dowel pins	2 min.
Set up the box in the press, press out the brass and remove the box from the press	5 min.
Cut off and drive out 8 rivets	10 min.
Remove 4 screws and take off the liners	5 min.
Total time	25 min.

Operation No. 4. Slot the outside of a new crown brass to fit the box.—The slotter operator sets a special gage, shown in one of the illustrations, to the inside of the box. The three points are adjusted accurately and then the gage is inserted in a slot in the top of the clamping fixture, on the slotter, which is also illustrated. The brass is slotted direct to the gage. By slotting this fit the corners of the brasses are also accurately fitted and no further machining or fitting is necessary before they are pressed in the boxes. The machine used is an ordinary single head slotter. The tool bar is clearly shown in the photograph of this

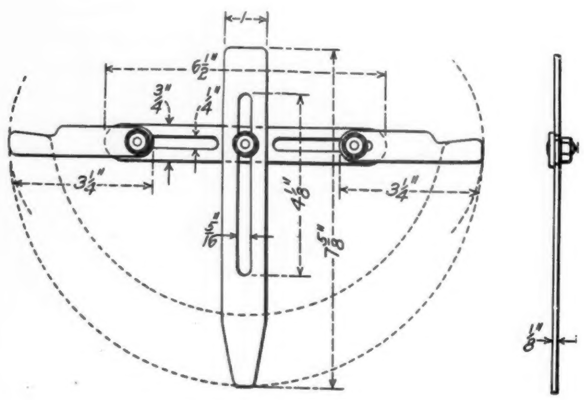


Section of the Winnipeg Shops Showing Arrangements for Driving Box Repairs; Canadian Pacific.

machine. A time study of the detail operations follows:

	Depth of Cut.	Feed.	Strokes per Min.	Min.
Set up and clamp the brass	....	....	......	8
Set the gage to box size	....	....	......	2
Set the tool	....	....	......	1
Slot the box fit	⅛ in.	1/32 in.	32	24
Gage and mark the corners	....	....	......	4
Change the tool	....	....	......	1
Slot the first corner	⅛ in.	1/32 in.	32	6
Reset the tool	....	....	......	1
Slot the second corner	⅛ in.	1/32 in.	32	6
Remove from the machine	....	....	......	3
Total time				56

Operation No. 5. Press in the crown brass.—The crown brass



Gage for Slotting Crown Brasses.

is pressed in by the same men that do the stripping. The detail operations are as follows:

Set up the box in the press	3 min.
Place and press in the crown brass	4 min.
Try in the cellar	2 min.
Remove and clean the table	3 min.
Total time	12 min.

Operation No. 6. Dowel and oil holes drilled.—From the press, the box is lifted by the hand traveler and placed on the table of a single spindle drilling machine, where it is drilled for the dowel and oil holes from the top outside, and the dowel pin holes are reamed from the inside. The detail operations are as follows:

	Diam. Drill.	Feed.	R. P. M.	Min.
Set up and clamp to the table	....	....	......	3
Set the drill	....	....	......	1
Drill two holes through the box and brass	1/16 in.	1¼ in.	130	5
Change the drill	....	....	......	1
Drill four oil holes	5/16 in.	1¼ in.	130	10
Reverse the box on the table	....	....	......	3
Change the tool and set the reamer	....	....	......	1
Ream two dowel pin holes	....	....	......	7
Remove the box from the machine	....	....	......	2
Total time				33

Operation No. 7. Mill the spring saddle pockets and the end of the shoe and wedge fit for the side liners.—It is necessary, on certain classes of boxes, to mill the pocket seats in which the spring saddle fits in the top of the box. These pockets wear hollow and require squaring out when the saddle is repaired. The dimensions of the pocket are; length, 8¾ in.; width, 1⅜ in., and depth, ⅝ in. The detail of operations are as follows:

Lift to the machine	6 min.
Set the milling cutter	2 min.
Mill two pockets square	30 min.
Remove from the machine	6 min.
Total time	44 min.

Certain classes of driving boxes, when equipped with new side liners, must be milled on each end of the shoe and wedge fit in order to allow the new liner to be applied. The average time required per box is 90 min.

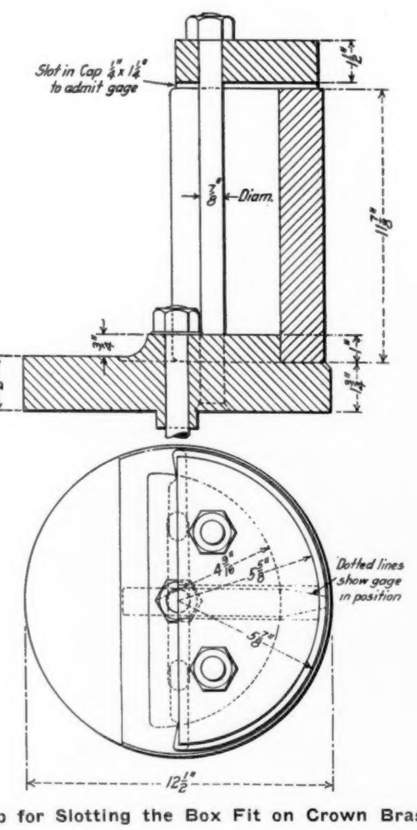
Operation No. 8.—Dowel pins applied, new side liners fitted and riveted.—Brass dowel pins are driven in, and the side liners are fitted and applied. They are fastened to the box by four rivets and two screws on each side. The detail operations are as follows:

Box in position, getting tools ready, etc	10 min.
Drive in two dowel pins	5 min.
Set the box ready to fit the side liners	2 min.
Chip and fit two side liners	30 min.
Lay off the liners for drilling	9 min.
Rivet eight copper rivets (four on each side)	25 min.
Tap the screw holes	5 min.
Apply four screws, saw off and rivet over	18 min.
Chip the oil clearance and file the burrs	10 min.
Total time	114 min.

Operation No. 9. Plane the shoe and wedge fit.—This operation is performed on a high speed planer of a new design. Two machines are necessary to handle the work. The boxes are set on the table on a block that exactly fits the shoe and wedge channel. The detail operations are as follows:

	Depth of Cut.	Feed.	Strokes per Min.	Min.
Set the box on the table for first side	....	....	......	10
Lay out the box from the center of the brass	....	....	......	5
Set the tool	....	....	......	1
Plane first side liner	3/32 in.	1/16 in.	20	4
Set for new cut	....	....	......	1
Finish plane first side	3/32 in.	1/16 in.	......	4
Turn the box over and reset	....	....	......	6
Set the tool	....	....	......	1
Plane second side liner	3/32 in.	1/16 in.	20	4
Set the cut	....	....	......	1
Finish plane second side	1/32 in.	1/16 in.	20	4
Remove the box from the machine	....	....	......	2
Total time				43

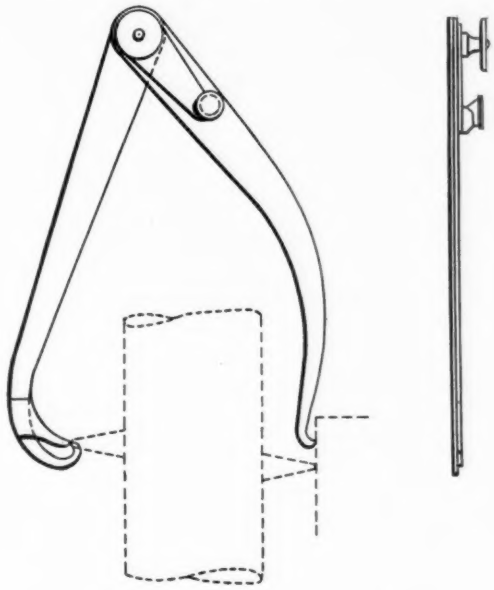
Operation No. 10. Bore and face the crown brass.—Although differing from the practice of many shops in this operation, boring



Clamp for Slotting the Box Fit on Crown Brasses.

and facing the boxes on a horizontal boring machine possesses advantages not common in other methods. Setting up is simple and requires no fixtures, other than a parallel block, which fits in the shoe and wedge channel; all other adjustments for the first box, vertical and horizontal, are obtained by the table adjusting screws. One of the illustrations gives a general view of the boring operation, and also shows the special caliper used in conjunction with it. This caliper is set from the ordinary calipers that gage the axle; with one point on the cutting tool, the other point calipers the brass in the same manner as with a

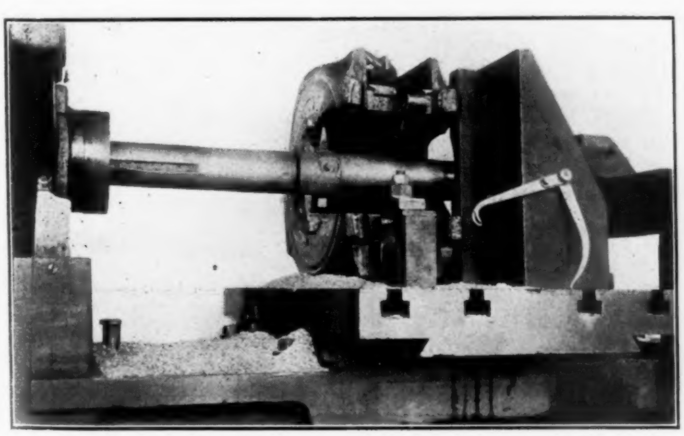
regular inside calipers. Another advantage of the boring bar is that all tools—roughing, finishing and facing, may be set at one time. The tool bar has slots at the correct positions for each tool.



Caliper for Boring Driving Boxes.

For a new crown brass, the boring detail operations are as follows:

	Depth of Cut.	Feed.	R. P. M.	Min.
Set up and clamp the box				5
Caliper the journal and set the special gage				3
Set one tool				1
Rough bore the brass	⅛ in.	1/16 in.	56	3
Set three tools				3
Bore the brass	1/16 in.	1/16 in.		..
Finish boring tool following	1/32 in.	1/16 in.	56	3
Radius and face the end		Hand	56	5
Remove from the table				2
Total time				25



Boring a Driving Box on a Horizontal Boring Machine.

When a new crown brass is not required, the old one is rebored in the following times:

	Depth of Cut.	Feed.	R. P. M.	Min.
Set up and clamp				5
Set three tools				3
Rebore the brass	1/16 in.	1/16 in.	56	3
Finish rebore following	1/32 in.			..
Radius the brass				2
Remove from the machine				2
Total time				15

Operation No. 11. Fit to journal, cut the oil grooves, fit cellars, etc.—After boring, the boxes are fitted to the journal and the oil grooves are cut with a pneumatic hammer. The cellar is then fitted and the pins are applied.

Fit one box to the axle	120 min.
Cut the oil grooves in the box (includes filing up)	25 min.
Fit the cellar and pins (includes grease springs)	20 min.
Total time	165 min.

Operation No. 12. Remove and renew babbitt liner.—If the box requires a babbitt liner, it is stripped by the fitter before leaving the bench. This operation is not done before the engine widths are supplied, so that babbitt to the exact thickness required can be applied. Babbitt liners are not machined after pouring.

Strip the babbitt liner	20 min.
Set the mold (steel) and pour a new liner	10 min.
Remove the mold and trim up	10 min.
Total time	40 min.

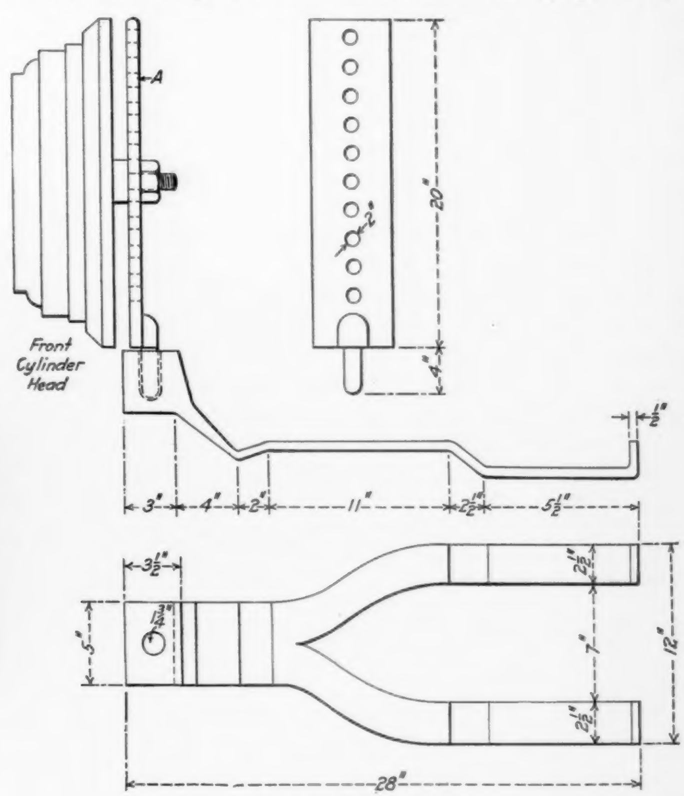
Operation No. 13. Assemble on the axle.—When a babbitt liner is applied, the boxes are brought back to the wheels to which they belong and the cellars are filled with hard grease, and then jacked up into position under the axle and the pins are inserted. The box may be assembled complete in 25 minutes.

[Criticisms of these methods, operations or the times allowed are invited.—Editor.]

CYLINDER HEAD CARRIER.

BY F. H. HINKLEY.

The arrangement shown in the accompanying illustration has been found very convenient when removing front cylinder heads. The frame will fit in any ordinary two-wheel truck, the right hand end slipping through and hooking under a cross bar of the truck. The cylinder head is fastened to the upright *A* by



Cylinder Head Carrier.

the casing stud. There are numerous holes in the upright to accommodate most any engine. With this device cylinder heads may be easily removed and replaced, and can also be carried from one engine to another, without any unnecessary lifting.

CITY WATER CONSUMPTION.—During the year ending June 30, 1911, the city of Detroit, Mich., had an average water consumption of 180.4 gal. per inhabitant daily.

MASTER BOILER MAKERS' ASSOCIATION

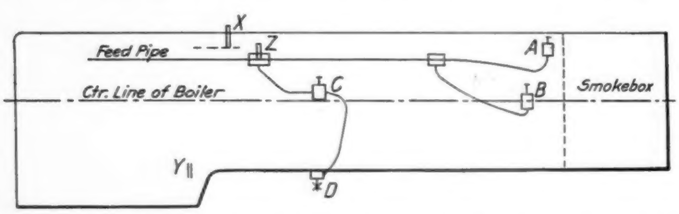
Important Subjects Considered at the Annual Meeting Included Location of Feed Water Admission, Brick Arches, and Effect of Superheated Steam on Boiler Maintenance.

The sixth annual convention of the Master Boiler Makers' Association was held in Pittsburgh, Pa., May 14 to 17, George W. Bennett presiding. The opening session was given over to addresses of welcome and responses. L. H. Turner, superintendent of motive power of the Pittsburgh & Lake Erie, spoke on the responsibilities and duties of the boiler shop foreman. William McConway, of McConway & Torley, told of the transportation facilities in the early days of Pittsburgh. J. F. Deems believed that far more could be obtained from the men by kind treatment than in any other way. Most men respond to kindness, and if they do not, the best thing for the shop is to get rid of them.

The association now has a membership of 218, and there is a cash balance of $391.77 in the treasury. Delegates were appointed to attend the meetings of the International Society for Testing Materials in New York in September and the Third National Conservation Congress at Kansas City, Mo., in September.

LOCATION OF FEED WATER ADMISSION.

A committee report was presented by D. G. Foley, chairman. The general practice followed in feeding locomotive boilers with water is to inject it through one of four different locations, i. e., at *A* on the front course of the barrel with individual checks on both sides; at *B* on the same course with duplex



Location of Check Valves and Thermometers on Boiler Which Was Tested.

checks; and at *C*, as well as *D*, with individual checks located on the back head of the boiler, provided with internal pipes discharging the water near the front tube sheet.

The common practice is to have the feed water enter the boiler in a solid stream at a low temperature. The uneven temperature causes an undue contraction of the firebox sheets and bottom flues, causing leaky boilers, etc.

Some roads use a plate on the inside of the boiler to deflect the water up over the flues after it enters, thereby preventing the deposit of scale on the inside of the shell, between the shell and the flues. This shows some improvement, but still shortens the life of fireboxes and does not prevent engines from leaking.

Another device is the upturned elbow in the boiler check. An upturned elbow with a contracted nozzle has been found to be a simple and effective device for equalizing the temperature of the feed water, but as near as we can find out it only brings about a difference of 15 degrees between the temperature at the top and the bottom of the boiler.

A more recent device for delivering feed water to a locomotive is the Phillips check, which delivers the feed water in a solid stream in the steam space. A road having 14 consolidation engines equipped with the Phillips double boiler checks considers it an improvement all around over the old method of boiler feeding.

The Seddon boiler feed device, which was designed and patented by C. W. Seddon, of the Duluth, Missabe & Northern, presents an entirely new idea. The feed water is discharged into the steam space in the shape of a spray; the small drops absorb the heat and fall to the surface of the water in the boiler at a uniform temperature. This method causes incrusting solids contained in the water to separate before they mingle with the boiler water, and these solids are collected in a sediment pan, thereby leaving the sheets and tubes free of scale. Another feature of the sediment pan is that the feed water is held in suspension before being allowed to mingle with water below, until it overflows the flange at the rear of the pan; this gives double assurance of the feed water getting heated to the same temperature as the water already contained in the boiler.

One road has 96 engines equipped with the Seddon boiler feed device and the records show gratifying results from its use; noteworthy is the 50 per cent. decrease in boiler maintenance, the increased life of fireboxes and flues, and the elimination of failures due to boiler troubles.

Enginemen are often careless in the handling of injectors, not realizing the damage caused by the flow of cold water. Ninety per cent. of the boiler failures can be traced below the boiler checks. Our idea is to feed the water in the boiler just as high as we can and spread it as much as possible.

To determine the most desirable location for the admission, a 10 minutes' temperature test was conducted under three of the methods of feeding with the following results. The No. 9 Gresham injector was on full and the boiler pressure was 130 lbs.

Check Valve Open.	C			B			A		
Thermometer.	X Deg.	Y Deg.	Z Deg.	X Deg.	Y Deg.	Z Deg.	X Deg.	Y Deg.	Z Deg.
Before injector was opened.	374	352	...	376	352	...	375	352	...
At end of 10 min. of open injector	377	274	171	376	328	172	376	334	174
3 min. after injector was closed	376	268	...	377	317	...	376	346	...
Difference in temperature between time of opening injector and 3 min. after closing	...	84	...	...	35	...	...	6	...
Difference between thermometers Y and X before injector was opened	...	22	...	...	24	...	...	23	...
Difference between thermometers Y and X 3 min. after injector was closed	...	108	...	...	60	...	...	30	...

Minutes. Test.	Feeding from bottom. Thermometer Temp. Bottom.	Top.	Feeding from side. Thermometer Temp. Bottom.	Top.	Feeding from top. Thermometer Temp. Bottom.	Top.
1	255	347	196	347	222	346
2	256	346	197	342	220	345
3	258	334	199	335	220	343
4	258	313	203	322	219	342
5	255	295	206	313	219	339
6	252	281	210	307	219	339
7	247	270	213	303	219	339
8	244	262	216	302	219	340
9	242	258	218	301	219	338
10	239	252	219	301	220	334
Drop	16	95	...	46	2	12
Rise	...	...	23	...	...	...

The top thermometer was located at the water line, while the bottom one was connected about 18 in. above the foundation ring. It will be observed that the greatest temperature changes took place when feeding through the bottom of the barrel, because the bottom thermometer dropped 16 deg. F. and the top one dropped 95 deg. F. Feeding through the sides, the bottom thermometer rose 23 deg. F. and the top one dropped 46 deg. F. Feeding through the top the bottom thermometer dropped

2 deg. F. and the top one dropped 12 deg. F. The fourth method was not tested. It was not in question because it is generally conceded to be an undesirable location for engines operating in bad water districts, due to the internal pipes becoming full of scale, and they are also subject to breakage, causing damage to fireboxes.

Feeding with duplex checks through the top of the boiler was found the most desirable location, because of developing the least fluctuation in temperature around the firebox and tubes, and engines which gave considerable trouble leaking when fed from the bottom or sides of the barrel were almost free from it when fed from the top, under like conditions, and operating over the same section.

When the water was fed from the bottom the fireboxes, except the crown sheet, were necessarily renewed yearly, and since feeding from the top the same engines, on the same section of the road, operating the same trains and using the same water, have doubled that service, with a correspondingly less amount of firebox attention, and have still more service in their firebox plates. The tubes also have given better results in service, and their mileage has been increased 50 per cent. between renewals (when feeding from the top). Cleaning plugs are required close to the duplex check when it is applied to the top because of deposits of foreign matter over and between the tubes at the front tube sheet end, and if this is not kept clean the tubes will leak at the front tube sheet joint.

In our opinion feeding from the top, near the front tube sheet, is the most desirable location for locomotive boilers, because we find the mud and scale better distributed throughout the barrel of the boiler and less lime and magnesia deposits are found adhering to the pressure side of the firebox plates than when feeding from any other location, and this appears to be why better results are obtained.

Discussion.—The discussion centered about the use of the Phillips check and the Seddon method of injecting the water. The latter is such that the water is injected near the top and is thrown upward into the steam space in the form of a spray; there is a shield over the upper tubes. With this arrangement the water is heated to a high temperature at the front end of the boiler and deposits all of its impurities there, so that the mud does not get back into the water leg and accumulate on the mud ring. The immediate result of its use on one road was a great saving in the amount of boiler work that had to be done in the engine house, cutting down the number of boilermakers from 14 to 7, and at the same time making it possible to increase the tonnage ratings of the locomotives. It was also claimed that it had an effect on the number of broken staybolts, which have been reduced 35 per cent.

It was urged that the principle on which this method of feeding acts is the correct one and that any other that would throw the water up into the steam space and then hold it in suspension on the top of the main body of the water until it had become heated to the temperature of the steam would accomplish the same purpose.

The principal points where it shows an improvement is in the flue and side sheet leakages. Of course, where the water is not purified, the same total amount of scale is deposited in the boiler, but it is dropped where it does the least amount of harm. Investigations have shown that where the life of the side sheets was as low as nine months with the water injected in the usual manner, it rose to two years with the sheets still in good condition with the Seddon device. Some trouble had been experienced with it due to the accumulation of the scale in the form of sulphate of lime at the front end. In some cases it was found that the tubes were so embedded in this scale that they could not be cut out with the ordinary methods of cutting, when it came time for renewal. It was urged that this condition could have been avoided by a more thorough washing out and not allowing so much of the scale to form. But even then, the evils of leaky tubes were very much less with the scale against the front tube sheet than they would have been had it been against the back sheet. As for the deposition of vegetable and organic matter, it does not make very much difference as to where it is deposited, as it may be easily washed out.

Where the accumulation of the scale at the front end has been allowed to become excessive, there has been some trouble with the leakage at the front ends of the tubes. Where the water is bad, the use of a surface blow-off is of great value in tending to keep the front end clean; the tubes should be removed before they get in the condition that has been described and before they are entirely blocked.

Another device used has a deflector over the dry pipe, and the water is fed into the steam space and allowed to flow down on it. This serves to thoroughly heat the water, but there is apt to be trouble by the scale forming a bridge or sheet over the tops of the tubes. This can, however, be easily removed by taking out the standpipe and getting inside the boiler to clean it out. This scale forms only on the two top rows of tubes and for about half way back.

On one road where the best results had been obtained there were 110 locomotives, of which 14 were fitted with the Phillips check and 96 with the Seddon's device.

It was frequently urged, throughout the discussion, that one of the best methods of securing good results from any method of feeding the water was to washout and blow off frequently. One case was cited where it was the practice to put four washout plugs in the bottom of the shell, two in the top and two in the front tube sheet. Washing out from the front end was considered to be the best method of cleansing the boiler. The automatic blow-off was also recommended, as it has a tendency to clear the boiler of scale and will have an effect at the upper portion where it is impossible to locate the washout plugs so as to be of any value. Cases were cited of engines on the same runs where the engineer in charge of one would make frequent use of the blow-off, with the result that there was little or no trouble from scale, while, in the case of the other, where the blow-off was not used, there was a great deal of scale and trouble with leaky tubes, with the consequent higher cost of boiler repairs.

The consensus of opinion of those who took part in this discussion was that the use of a method of water feeding that sent the water up into the steam space at the front end was of greatest value.

APPRENTICESHIP.

J. W. L. Hale, superintendent of apprentices of the Pennsylvania, gave an illustrated address on this subject. It did not refer specifically to boilermaker apprentices, but covered the general problem of apprenticeship. There are now 250 apprentices at the Altoona shops. This large number makes it possible to group them into classes and sections, thus securing better results than where the number of apprentices is so small that they cannot be thus grouped. Each apprentice receives four hours' of school instruction per week, divided into two periods of two hours each. This instruction is given during working hours and while the boy is under pay. A certain amount of home problem work is also required. The appentices work in the shop with skilled mechanics. The monthly reports of the boys' school work, taken in conjunction with the regular records of the shop foremen, form a satisfactory and reliable basis upon which to place the boys to the best advantage in the shop. There was no discussion of this paper.

WEAKEST CONDITION OF BOILER.

The committee, of which J. T. Johnston was chairman, presented a short report, the conclusion of which was as follows: "In conclusion your committee wishes to state that in its opinion the elastic limit of the plates, braces, etc., used in the construction of a boiler, should be considered, rather than the ten-

sile strength, in maintaining boilers in safe working condition." There was no discussion of this report.

SPARK ARRESTERS.

Thomas Lewis presented a report on spark arresters, in which he referred at some length to practical demonstrations in fuel economy which were made on the Lehigh Valley.

Discussion.—A few blueprints were presented showing the practice on some roads, but the recommendation of the committee that the front end, known as the Master Mechanics' standard, is about as good an arrangement as can be obtained, was concurred in. Attention was called to the excessively long front ends, that were the vogue a number of years ago, where the sides were provided with handholes, and the bottoms with chutes for the removal of the cinders; there was a great accumulation of cinders at the end of every run. It was found that when there was a failure to clean out at the end of a run, there was no greater accumulation at the end of the second or third run than at the end of the first. The smokebox simply filled up to a point where the draft could have the proper effect, and after that, to all intents and purposes, the front end became self-cleaning. With the arrangement recommended the diaphragm was carried down and in front of the exhaust pipes so that a strong current was created that carried the cinders to the front with sufficient force to break them up and make them small enough to pass through the netting.

In some cases the basket netting is in use. This, as its name indicates, is a netting in the form of a basket that sets down over the exhaust pipe and is free for the passage of cinders all of the way around. Where this is used there is a 10 in. opening in the firedoor. This is covered by a damper, and the single-shovel method of firing is used. As the fireman throws in a shovel of coal, he puts his foot on a lever that opens the damper, admitting air to the back end of the firebox and supplying sufficient to maintain complete combustion and thus avoid the formation of smoke. It was suggested that so large an opening would not only supply enough air to maintain complete combustion, but would admit such an excess as to greatly cool the fire and prevent obtaining the full heating value of the fuel.

With the diaphragm made in the form suggested there is no accumulation of cinders in the smokebox, and it is self-cleaning; whereas, where the diaphragm stopped back of the exhaust pipes the draft created was not sufficient to do the work of breaking up the cinders so that they could pass the netting.

As for the size of the mesh of netting that it is advisable to use, the practice of the engines running in the Adirondack region of New York state was cited. Here experiments had been made with nettings of three and four meshes to the inch, but the final size adopted was 2½ meshes to the inch, using No. 11 wire. This arrangement seems to have almost put an end to the fires started by locomotives. Formerly the losses in the region amounted to hundreds of thousands of dollars every year, but last year they were not over $10,000.

Some of the speakers advocated the use of a perforated steel plate instead of a wire netting, and stated that excellent results were being obtained by its use. The size of the perforations recommended was 3/16 in. by 1 5/16 in.

Finally attention was called to the necessity of so arranging the diaphragm that the front end should be self cleaning. The cases of the old extension front were cited where it was necessary to make the whole of the smokebox air tight, for, if any air was admitted to the large body of cinders, it would cause them to burn, with the result that the ends frequently became red hot. With the self-cleaning front end such a thing as a hot smokebox is unknown.

THE BRICK ARCH.

An abstract of the report of the committee on Advantages and Disadvantages of the Use of Arches and Arch Pipes, of which George Wagstaff was chairman, follows:

The committee endeavored to determine as accurately as possible what the advantages of the brick arches are and the true value of these advantages. It has also been the endeavor to determine definitely the disadvantages of the arch and arch pipes and, as far as possible, the actual cost to the railways of these disadvantages.

Under advantages are the following items: 1, Coal saving. 2, Smoke abatement. 3, Flue protection or reduction in roundhouse flue work. 4, Improvement of steaming qualities under demands for maximum power. 5, Reduction of engine failures from leaky flues and low steam. 6, Reduction in flue stoppage. 7, Reduction in honey-combing of flue sheets. 8, Beneficial effect of the arch tubes on circulation and evaporation. 9, Effect on the life of a set of flues.

Under "disadvantages" may be listed the following: A, Cost of maintenance of the brick. B, Cost of maintenance of arch pipes. C, Detrimental effect, if any, on fireboxes. D, Delays, if any, to the turning of power at the engine house due to the presence of the arch in the firebox.

Coal Saving.—The replies are almost unanimous in stating there is a coal-saving, the average of the percentages given being 11.9 per cent. This percentage virtually checks or verifies the result of a very comprehensive test recently made to determine the coal saving of the arch. The test was conducted by a committee made up of representatives from the Pennsylvania Railroad, the New York Central and the American Locomotive Company on a Mallet engine on the Pennsylvania division of the New York Central. The conclusions were to the effect that the brick arch under the conditions tested gave a fuel saving of 11 per cent. We also have information on other well conducted tests which would indicate a coal saving of 12 per cent., or more. The coal saving reported by the different members varies from a slight saving to 25 per cent. This might seem inconsistent but for the fact that the conditions under which these various percentages were obtained are evidently quite variable. The percentage of coal saving varies largely with different degrees of intensity of the work. For very light work the percentage will be slight. For very high rates of work, or rather high rates of combustion, the percentage should be high. Again, when the coal is of a low volatile nature the effect of the brick arch on coal saving will not be so great, but with high volatile coal there is much for a brick arch to do and under such conditions it will show a high percentage of fuel saving. The committee feels that 11.9 per cent. may be considered a fair figure for the average conditions.

Assuming a locomotive working 330 days in a year, running 100 miles per day and making on an average of 20 miles per ton of coal, the tons of coal consumed per year are 1,650 tons; 11.9 per cent. of 1,650 tons is 196 tons; money value at $2 per ton, $382.

Smoke Abatement.—The composite report shows favorably for the arch from a smoke abatement standpoint, the average being 40 per cent. This again depends on the nature of the coal used.

Effect on Flue Work and Percentage of Reduction of Frequency of Calking.—Thirty-five report reduction in flue troubles. Two find additional flue troubles, while three report no effect. The average percentage of reduction in frequency of calking is 40 per cent. Just what money value this would represent we are not able to determine, but it would no doubt be considerable.

Steaming Qualities Under Maximum Demand.—Forty-five replies say that arches make the engines more consistent steamers; one reply states, no effect. This would indicate that arches were of decided value. Just what the money value would be we cannot state. However, it indicates that by using brick arches better schedules can be maintained, a thing very important to the railways in competing for high class business. It may mean less double heading, a thing much to be desired. A very small reduction in the number of cases of double heading would pay

for much of the brick arch expense. It can mean more tons per train hauled and thus more ton-miles per ton of coal consumed.

Do Arches Tend to Reduce Engine Failures.—The vote on this item is 42 to 5, indicating that arches do reduce engine failures.

Do Arches Reduce Flue Stoppage.—The vote on this item is 37 to 10 favoring the arch.

Honey-Combing of Flue Sheets.—The vote on this is 29 to 9 in favor of the arch.

Effect of Arch Pipes on Boiler Efficiency, Circulation and Evaporation.—Replies indicate 23 favorable to and two neutral on these points. A previous report to the association shows a fraction over one per cent. gain of efficiency per arch per pipe. This gain would more than pay the arch pipe maintenance cost.

Effect on Life of Flues.—Thirty-two replies say lite of flues is increased, two say the life is decreased and four say no effect.

As against the above advantage we have the possible disadvantages as follows:

Detrimental Effect on Life of Firebox.—Five claim that the arch with arch pipes prolongs the life of the box, 12 that the life of the firebox is shortened, while 14 report no effect, less than half reporting detrimental effects. A careful review indicates that the experience of those reporting detrimental effects is largely in connection with brick arches supported on studs. It would, therefore, indicate that the effect of the arch on the life of the firebox would depend on the style of the arch used. It would indicate that arches of the proper design supported on tubes have no bad effect on the life of the firebox. At any rate, we believe that we may safely draw the conclusion that the beneficial effect of the arch on the flues will at least offset any possible detrimental effect which the arch may have on the firebox.

Are Engines Held Longer at Terminals on Account of Arches.—The vote on this item is 29 to 12, indicating that less than 30 per cent. of the members reporting find that there is a delay to the turning of power due to brick arches. Several members report less delay to engines equipped with arches. It would seem that the style of the arch has some bearing on this point. One man reports that there is no delay if sectional arch is used. The majority of those reporting no delays are using the sectional arches. Your committee, therefore, feel justified in saying that the delay in the turning of power claimed by some, is not an unsurmountable disadvantage. There are good grounds for argument that in the majority of cases this belongs on the other side of the ledger, due to 40 per cent. reduction in roundhouse flue work.

Cost of Maintaining Arch Pipes.—The recapitulation shows an average of $4.36 total to renew one arch pipe, and the average life of an arch pipe to be 14 months. With four tubes in an engine there would be an average renewal of one tube every three and one-half months. At a cost of $4.36 each, the arch pipe cost per year in a box equipped with four tubes would be $15.26. This, we believe, represents a fair average for the cost of maintaining arch pipes.

Cost of Maintenance of Brick Arches.—The replies gave us no line on the cost of maintenance of brick per 1,000 engine miles. We have data, however, showing that the average life of a set of brick in passenger service is 5,490 miles, in freight service 4,425 miles, and in switch 6,500 miles. Assuming 33,000 miles per year as the average for an engine, it would require about 6 arches per year for passenger engines, and about eight arches per year for freight engines. Not having replies on the cost of arches, we are obliged to make some assumptions. We know from other sources that the cost per 1,000 miles for arches in wide firebox locomotives will be between $1 and $3. These wide limits are necessary on account of the wide differences in conditions throughout the country. The condition of the water has a decided effect on the life of an arch; the quality of the coal also has a decided effect and the intensity or degree of severity of the service greatly affects the life of the arch. Assuming $2 per 1,000 engine miles as a probable average and a mileage of 33,000 miles per year, we have for the cost of brick, $66 per year per locomotive. Add to this the brick arch labor, given as an average of $1.70 per month, we have $20.40 for brick arch labor per locomotive per year; add to this the cost of maintenance of arch tubes which we found above to be $15.26 per locomotive per year; and figuring the storekeepers' cost at 2½ per cent. as the average, we have a grand total of $103.31 for the average cost for the yearly maintenance of brick arches and arch pipes in an average modern locomotive.

Compare this with the money value of the advantage of the brick arch, which we found to be on coal saving alone, at about $392 per locomotive per year with the coal at $2 per ton. Subtracting from these coal saving figures the total cost to maintain the arches, we have in districts where coal costs $2 per ton a net saving of $275 per locomotive per year.

To sum up, weighing the advantages against the disadvantages. it appears from the replies received that brick arches are giving a very good account of themselves on 26 of the 30 roads reported on.

Many roads have recently adopted the use of brick arches and superheaters, not so much from a desire to burn less coal, but in order to obtain more steam of a better quality, due to the necessity of having maximum sustained boiler power for a minimum of weight and operating expense.

The committee's recommendation, therefore, may be expressed as follows: The improvements in brick arch construction and the advancement in the art of boiler maintenance, including care of arch pipes, render the disadvantages of the use of arches so small in comparison with the advantages derived as to warrant the general use of brick arches in soft coal burning locomotives.

Discussion.—The consensus of opinion was that the arch was a good thing, though it was recognized by nearly every speaker that there were troubles, but whether they were inherent in the arch or not was not always clear. It was urged that contrary to the opinion sometimes held, the brick arch served to protect the side sheets from burning and was a promoter of circulation.

The question was asked as to what should be done in case the side sheet gave out so as to need patching and how the top seam of the patch could be kept from leaking. In reply it was urged, in the first place, that the sheet would not be likely to give out with a properly applied arch, but that if a patch was necessary it would be well to apply it with the oxy-acetylene method of welding, which would leave the sheet in first-class condition and not likely to leak.

It was assumed by all the speakers that the arch pipe was the proper method of supporting the arch, and it was said to be of great value as a promoter of circulation. It was in a position to take the water from the front portion of the boiler and carry it up to the back of the crown sheet, and the probabilities were that the circulation through the pipes was exceedingly rapid, and that the amount of water evaporated there was very great. The use of four supporting pipes and the sectional arch was strongly recommended. There was very little complaint of leakage of the pipes. The use of a bead was condemned and the general opinion was in favor of allowing the pipes to project through the sheet from ¾ in. to 1 in., and then bell them out so that there was no danger of pulling through. The main thing that was insisted on again and again was that the pipes should be kept clean. They should be frequently examined and a cleaner run through them where there is any danger of an accumulation of scale forming. Some members seemed to think that the arch would do very well in good water districts but that where the water was bad there would be no end of trouble. This was from men who were not using the arch and they were

met by statements from men who were in the worst of the bad water districts to the effect that they would work all right in any kind of water provided they were given the proper attention. They are used where the water will deposit 1/4 in. of scale in three months.

The trouble with the bagging of the pipes on the bottom was brought prominently to the front. While there was no actual data given that could settle the matter, it was urged that one of the possible reasons for this trouble could be found in the thickness of the metal used. Most of the members were using steel pipes with a diameter of 3 in., and a thickness of metal of about 3/16 in. In one case where such a tube had bagged and had to be taken out, and there was no other extra pipe at hand to replace it, a piece of tubing 1/8 in. thick was used, and this had stood perfectly and had shown no signs of bagging. Another speaker argued that the trouble with bagging was irremediable because of the conditions under which the pipe had to work. It was covered and protected on the top by the brick, whereas on the bottom it was exposed to the hottest part of the fire. This caused such an expansion of the metal that it must of necessity bag. It was suggested that possibly the trouble may have come from the great rapidity of the circulation and that it was due in part to an abrasion of the metal. To remedy this it was suggested that it might be well to reduce the diameter of the pipe at the front end so as to limit the amount of water that could pass through. There was an immediate protest against this and the contrary course of enlarging the pipe was urged. The same trouble is experienced with the tubes of water-tube boilers. The thickness of the pipe was also considered to have an important bearing on the subject, and as better results have been obtained with side sheets of 3/8 in. thickness than with those of 1/2 in., so it was thought that the thinner pipe would be better than a thicker one.

The failure of the pipes is a serious matter in some places where they have to be renewed within a week of the date of their application. Sometimes they run for two and sometimes for three weeks. It was suggested that if the pipe could last one week it ought to last for two, or three, or more, if it had the proper care and attention. One thing was brought out very emphatically, and that was that the bagging of the pipes is not due to the accumulation of scale, for, in many cases, where the worst bagging has occurred, the pipes have been perfectly clean, and besides, there had not been time to collect any scale in the limited time in which they had been in place.

The theory that received the greatest amount of support was the one that there was a lack of water against the bottom of the pipe. Attention was called to the practice on some locomotives of using wide crowfeet for the braces of the front tube sheet. Sometimes these braces are set in so thickly that there is but little space left for the water to flow down into the water leg and thus reach the mouth of the pipes. It was considered desirable that these braces should be made as narrow as possible and set well to the front so as to allow ample water space and thus make it possible for the pipes to be kept filled at all times. Bagging evidently is not due to the water used, for it is as likely to occur with good as with bad water. The point where the maximum amount of bagging occurs is not well defined. It runs from the front tube sheet back to the back sheet, and may occur at any point, though one speaker said that his main difficulty had been found on a line with the back edge of the arch. Another had had his chief difficulty at the lower bend of the pipe. Straight pipes were considered to be more likely to give trouble than those with bends where there was a chance for expansion and contraction to adjust themselves. One point was insisted on, that while some districts were able to use the arch pipe, and some were not, it would be found that those where the pipes could not be used were where the water had a tendency to foam.

The type of arch used on the Lake Shore & Michigan Southern switch engines was described as one in which the standard sectional arch was carried back from the front tube sheet for a distance, and then there was an opening in it, and beyond the opening there were two bricks set against the back sheet so that there was practically an arch over the whole of the firebox with a hole through it for the passage of the products of combustion. Sometimes this construction is varied by the cutting away of the corners at the back and front ends. These arches are applied to switch engines for the purpose of abating smoke.

As for the saving effected in coal by the use of the arch, there was a unanimous agreement as to its efficiency. On the Lake Shore it is estimated that the saving amounts to from 8 to 10 per cent. of the coal that would be used in case the brick arch was discarded. On one road having 110 locomotives the estimate is that there is a saving of $50,000 per year by the use of the brick arch.

The attitude of boilermakers towards the brick arch in the matter of repairs seems to have undergone a change during the past few years. The opposition to it formerly was due, in part, to the heat and the trouble that was involved for the men who had to go into the firebox to calk tubes while the engine was hot. With the long brick in use, it was frequently necessary to break down the arch to do the work. With the sectional arch now in use this is avoided and the center sections can be easily removed. It is never necessary to break down an arch, and only frequently is it necessary to break any of the small brick forming the sections. It has been found to be best to have regular brick men to attend to this work and not have the boilermaker touch the arch at all. The method of procedure is for the brick man to go into the firebox and remove as much of the arch as may be necessary. The boilermaker then does his work, and after he is through, the brick man goes back and replaces the arch. As for the time required for the boiler to cool sufficiently to enable the men to do this work, on one road where the passenger locomotives are dumped at the end of each trip, and the freight locomotives once in seven days, it is seldom more than 20 minutes or half an hour before the men can go into the firebox from the time the engines leave the cinder pit.

The brick arch is like all other parts of the locomotive. In order to get good and satisfactory results it must be properly applied, and then given good care while it is in service. It should be cleaned off and kept free from accumulations of cinders. The life of the arch is given in miles in the table in the report, but, in the discussion, it was stated that on one road the life ran about 30 days in passenger service, 42 in freight and 144 in switching. It was stated that brick arches cannot be used to any advantage on oil-burning locomotives.

The value of the brick arch as a smoke preventer was conceded, but in order that it may do its best work in this connection it is necessary that it should be properly installed and cared for.

As an aid to combustion it was agreed to be very valuable. In some cases where before it was used there was a great deal of difficulty with the fine particles of coal being carried out through the tubes before they had a chance to burn, and forming a sticky mass that obstructed the netting and the tubes, the whole trouble disappeared with the introduction of the arch. As for its influence on the side sheets, if there is any trouble there it should not be attributed to the arch and the hotter fire that it produces, but to the bad condition of the water that is used. There does not, however, seem to be much if any advantage to be gained from its use on locomotives having shallow fireboxes. It is true, too, that, if the arch is not properly applied, it will cause trouble with the sheets. In one case where the arch was carried up to a point rather close to the crown sheet, there was a great deal of trouble with the leakage of the longitudinal seam of the firebox. This disappeared when the top of the arch was dropped. It is true that the arch stores

a great deal of heat, and that if this heat is brought up against a seam there will probably be trouble, and it was for that reason that the recommendation was made to weld in patches instead of riveting them.

It was the opinion of the speakers that the arch and the pipes that support it was as safe as any other part of the boiler, if it was properly attended to and the pipes were kept clean.

The arch is an old institution, and its use is based on the proper principles for the production of the best rate of combustion of the coal, and it has come to stay. The reason why the old arches were so discredited is that they were often made of inferior material and were not made of a proper shape; now that the sectional arch has been introduced, these former troubles with the arch as an arch have disappeared, and with them the old arguments against its adoption.

SUPERHEATED STEAM AND BOILER MAINTENANCE.

A committee report on this subject was presented by T. W. Lowe, chairman. The fire tube type of superheater only was considered. The large holes in the front tube sheet are generally drilled about ¼-in. larger in diameter than the body of the flue, the flue being swelled hot to fit that end before application, thus economizing on the labor attached to removals. The large holes in the back tube sheet are drilled smaller than the main flue, which is swedged several inches back, thus providing an abundance of water space at the firebox end, as well as ample material between the tubes, to prevent cracking of the interstices during the setting and maintaining of the flues. No copper ferrules are used to surround these large flues in the back tube sheets, and they are either welded in place or rolled to a joint by using four rollers in the tube expanders, then lapping and beading both ends of the flues with a suitable sized beading tool to take care of the thicker flue.

These large flues are handled in the shops under the same general methods that are followed with smaller flues; the safe ends are welded with a proportionately heavier roller tube welder, and the firebox end of the flue is swedged with a hydraulic push swedging machine or suitable top and bottom die. During six years' experience we have had no weld failures, and are practically free from leakage in service because of reasonable attention, such as stopping all leaks after the fire is drawn, whether reported leaking on arrival at the terminal or not, and, further, by blowing out all cinders with air.

The working steam pressure on superheated engines is generally 180 to 200 lbs., and on light power 160 lbs. The same size engines and boilers under the two former pressures, operating in good and bad water, have not yet shown any marked difference in the cost of boiler maintenance, and unless there is a saving in machinery expense with the low pressure there does not appear to be any good reason why the 200-lb. pressure engine is not better and more powerful than the 180-lb.

Superheating has not reduced the mileage run between washouts and, although the firebox space is found in better condition, we cannot accurately compare the quantity of scale and mud collected between washouts; yet we are satisfied there is a better all-round condition and decreased foaming of the boilers in service.

Competent authorities state that there is a saving in fuel averaging from 10 to 25 per cent. in favor of superheating, the fluctuations during the tests being due to conditions. This is accompanied with a corresponding decreased consumption of water, and a longer life for flues and firebox plates, but because of many other mechanical improvements, which are under experiment at the same time, no accurate statement can be given to show the advantage derived from each; notwithstanding all this there is sufficient proof that there is a much greater percentage of benefit derived from superheating on locomotives than has been attributed to any other known mechanical device introduced on locomotives for many years, and its relation to the upkeep of the locomotive boilers is such, that with ordinary care in the application of the device and proper maintenance in service, the boiler is generally benefited.

During the severe frosty weather in northwestern Canada the superheater engines developed less flue and boiler failures compared to former saturated steam engines, which of itself is an economy not to be overlooked.

Discussion.—The discussion touched lightly on the relation of superheating to the upkeep of the boiler and centered almost entirely on the methods used in applying and replacing the tubes that are used for the superheater units. The major portion of this part of the discussion hinged about the large tubes that are used to carry the superheater units.

A representative of the Canadian Pacific stated that in all of the locomotives on the western section of that road, the superheater tubes are put in without using a copper ferrule in the back sheet. Other speakers advocated the use of the ferrule as a necessity in most cases, and statements were made to the effect that, in certain districts where the water was bad, it would be impossible to run the tubes without the copper ferrules. A practice that was warmly commended was that of the Chicago, Burlington & Quincy, where a very long ferrule is used. This ferrule has a length of about 1 in., and is first rolled into the sheet. Then the tubes are driven in and expanded and rolled out against the inwardly projecting portion of the ferrule inside of the sheet. The result is that, while the cost of the ferrules is more than for the shorter ones, there is very little difficulty experienced with leakages, due to bad treatment over the cinder pit. When the tube cools and shrinks, the ferrule on the inside of the sheet hugs it and maintains a tight joint, while the portion that is rolled in the sheet holds it tight. The result is that there is very little leaking of the tubes and a corresponding small amount of tube work to be done in the engine houses.

There was a decided difference of opinion as to whether the safe-ending of the tubes should be done at the front or back end. Those who favored the safe-ending at the back end claimed that it was the proper thing to do, because it put the new material that was in the tube at a point where the service was the most severe; while those who favored the front end claimed that a tube should not be used again if it was too thin to be used at the back sheet. Of course the tube would be thinner, and this difficulty was met by upsetting the end and bringing it back to its original thickness and then annealing it so that it would be practically a new tube so far as the rolling and expanding to which it might be subjected was concerned. In any event the back end of the tubes should be swaged down. This is recommended for two reasons. In the first place it gives more room between the tubes for the circulation of the water, and that very room makes better bridging possible. In putting these tubes in place it is well to use the expander and avoid the roller as much as possible. The expander should be a 12-section expander, and when the roller is used it should be of the 5-roller type, and not the 3-roller, as the arc between the rollers of the latter type is so great that the rolls are apt to push the metal on ahead of them and form corrugations.

Another method of putting in the large tubes that has been abandoned was to thread the holes in the sheet and the end of the tubes and screw them in. It was found that the tubes so treated would break off in the thread.

Where copper ferrules are used for the tubes they should be somewhat larger than those used for the small tubes, because of the greater stresses and pressure to which they are subjected.

A third method of safe-ending the tubes was suggested, and is in use. It is to make the first safe-end at the front and the second at the back, and then alternate until the tube is worn out. Still another argument presented for the safe-ending at the front was that it was well to have the weld as far from the fire as possible. Again, those favoring the back end, asked, why, if it was all right to have the old tube in the back sheet, it

would not be well to effect a still further saving and use old tubes for the safe-ends instead of buying new material? To this there was no reply.

A method of applying safe-ends was described. It consists of first swaging; then measuring the engine in which they are to be used; then welding the length, welding for the front end; then opening the front end to fit the holes. It was urged that in doing this work a standard system of tools be used. Where there are three sizes of beading tools, the Nos. 1, 2 and 3, the first being the smallest, and the last being that used for the large tubes, it is very bad practice to use the small tool on the large beads. The tool used should fit the bead, otherwise it will be cut, and bad results in the way of leakage will occur.

It was generally conceded that the life of the large tubes used for the superheater was longer than the small fire tubes of the boiler, and that this extra life frequently amounts to as much as two times or more between tube removals. Also that the life of tubes in superheater locomotives was longer than those of the ordinary locomotives. One reason assigned for this was that the superheater engines were frequently run with lower boiler pressures than engines of the same class using saturated steam. This because it is possible to use larger cylinders without incurring the disadvantages of cylinder condensation. Now it is well known that boiler repairs and troubles increase with the steam pressure, and this reduction of the working pressure with the superheater naturally causes a reduction in the amount of boiler repairs. It was agreed that the life of these tubes as well as that of the regular tubes of the boiler is more dependent on the water that is used than on any other one thing.

Finally it was brought out that the value of the use of the damper for the protection of the large tubes from the fire when the engine is drifting is dependent on the character of the road. On steep mountain divisions where there are long drifting distances the damper had best be retained. But, where the road is level or undulating and the drifting distances are short the damper can be removed without being in any way detrimental to the tubes, and this has been done in a number of cases.

CRACKING OF FLUE SHEET IN TOP FLANGE.

J. W. Kelly presented a paper on the Best Method of Staying the Front Portion of the Crown Sheet on Radial Top Boilers to Prevent Cracking of Flue Sheet in Top Flange. The practice of applying flexible stays to the crown sheet to afford relief to the flange of the back flue sheet and thus prevent the strain that has a tendency to permanently bend the sheet when rigidly connected, is now quite extensively followed by many of the railways installing flexible or adjustable stays four rows back from flue sheet, while a few have made full crown sheet installations. The use of the adjustable or flexible crown stay allows a clear water and steam space unobstructed, other than by the diameter of the bolts, and thus presents a better condition to keep the crown sheet clean and free from accumulations of incrustations, as compared to other methods of staying.

The more rigidly the complete firebox is stayed, the greater is the liability of distortion. Rigid staying serves to restrict the relative movement of firebox plates under expansion, and the difference in the expansion of one plate over the other is the feature that demands great consideration.

In a paper on the same subject T. W. Lowe thought that 3 in. was about a proper radius for tube sheet flanges, and the edge of the tube holes should never be closer to the root of the flange than 4 in., so that when this condition exists, assisted by good treatment, the back tube sheets will be worn out in the body in advance of the top flange cracking circumferentially, regardless of what design of stays are applied at and near the front end of the crown sheet.

There are several forces which tend to produce these cracks, such as the boiler pressure tending to crush the flange; expansion and contraction of the tube sheet body; a rigid crown sheet and side sheets united to the flange of the tube sheet by riveting, and secured to the outside shell with staybolts, thus preventing the tube sheet from altering its shape; and the surging of the water during the application of the air brakes.

We cannot get away from the boiler pressure tending to crush the flange.

Expansion and contraction of the tube sheet body. Considerable relief is assured when the method of maintaining tubes in the roundhouses is regulated to take more out of the tubes themselves, rather than developing severe stresses on the sheet, and further by not lowering the temperature of the boiler abnormally during washing out, or in handling at the terminals.

Referring to rigidity preventing the shape of the tube sheet altering. Where flexibility is adopted with the staying, the boiler pressure prevents the movement of the tube sheet in the direction it requires to go to prevent cracking, so that even flexibility with the staying, or design, does not remove the cause altogether, but helps to delay cracking.

Surging of the water in the boiler during the application of the air brake. A close examination around the pressure side of the top tube sheet flange discloses an innumerable number of incipient cracks, apart altogether from those developing over the tube holes; these appear to be related to the common star cracks which develop on the water space side of plates affected by bad water, and to those of us who frequently ride engines, and know the result of the air brake application whereby the water surges forward, the necessity for a mechanical device to retard the water should appeal, and particularly so when we know that the tube sheet flanges on passenger power with 20 ft. tubes are afflicted earlier and more severely than ordinary freight engines, with shorter tubes; this leads to the belief that the top flange suffers continuously from abnormal temperature, and a retarding device near the tube sheet would assist in keeping water at this location if there is sufficient carried in the boiler, and thus delay failures in the top flange of the back tube sheet, until the general condition demands the renewal of the sheet.

The next clause of this topic is Cause of Flue Holes in Back Flue Sheet Elongating and a Preventive for Same. My experience is that impure water is the cause of this defect developing, and until purification plants are installed to provide purer water, the only means whereby we can reduce the evil is by frequent renewal of the tubes, and preventing the staff destroying the tube holes in endeavoring to make scale or mud separate from the tubes, so as to be accessible to washing out, and I find where this is practiced the reamer will keep the tube holes in good condition.

OTHER BUSINESS.

The following officers were elected for the ensuing year: President, M. O'Connor, general foreman boiler maker, Chicago & North Western; first vice-president, T. W. Lowe, general boiler inspector, Canadian Pacific; second vice-president, James T. Johnston, assistant general boiler inspector, Santa Fe System; third vice-president, Andrew Green, general foreman boiler inspector, Big Four; fourth vice-president, Dan Lucas, general foreman boiler inspector, Chicago, Burlington & Quincy; fifth vice-president, John Tate, general foreman boiler maker, Chicago, Milwaukee & St. Paul; secretary, Harry D. Vought, New York; treasurer, Frank Gray, foreman boiler maker, Chicago & Alton. For members of the executive committee: B. T. Sarver, foreman boiler maker, Pennsylvania; A. Lucas, foreman boiler maker, Chicago, Milwaukee & St. Paul; W. H. Laughridge, general foreman boiler maker, Hocking Valley.

It was announced that Chicago had been chosen for the next place of meeting.

LOCOMOTIVE PRODUCTION.—The Borsig Locomotive Works, Berlin, Germany, had turned out 8,000 locomotives by last October. The number reached 7,000 in June, 1909, and 6,000 in November, 1906.

THE MOST POWERFUL LOCOMOTIVES

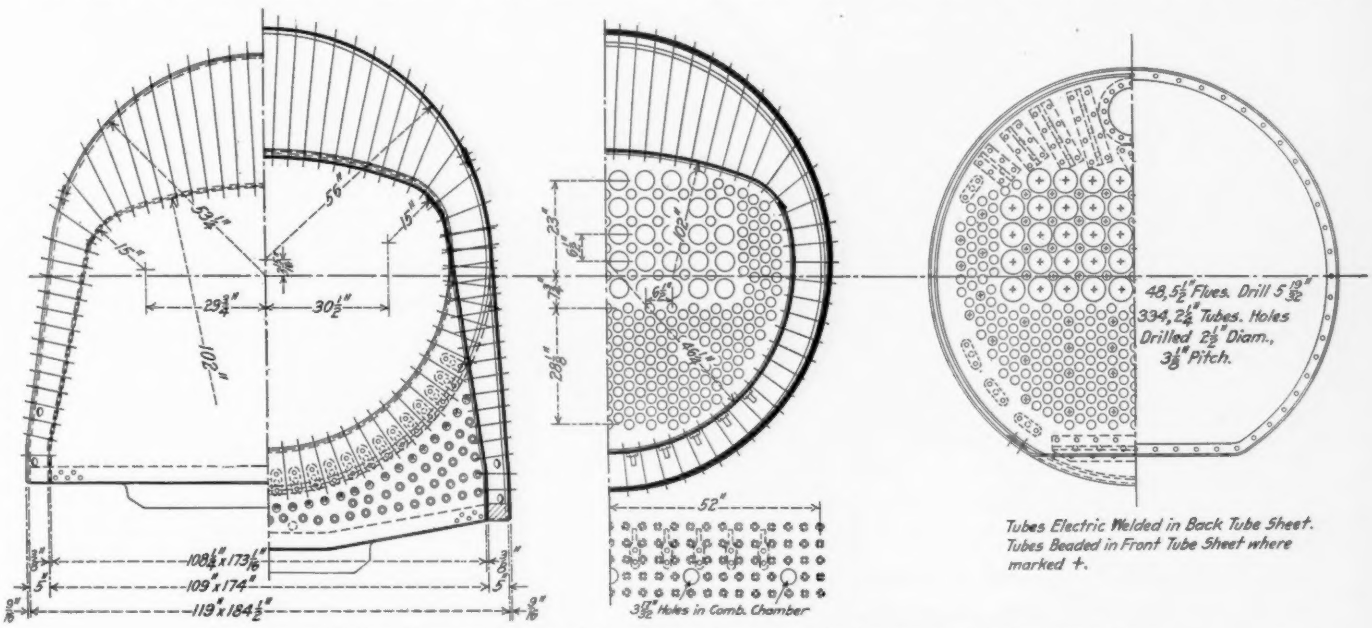
A Maximum Theoretical Tractive Effort of 138,000 lbs. Makes the Mallets for the Virginian of Unusual Interest Previous Designs Exceeded in Every Particular Except Weight.

Four locomotives with a tractive effort of 115,000 lbs. working compound, which is obtained with less than 60,000 lbs. average weight per driving axle, have just been built for the Virginian Railway by the American Locomotive Company. In every particular except weight the engines outclass all others. They were developed to meet particularly difficult conditions on this road and are expected to increase the train load on the Deepwater division from 3,340 tons to 4,230 tons. They will be used entirely in pusher service on a 14 mile grade.

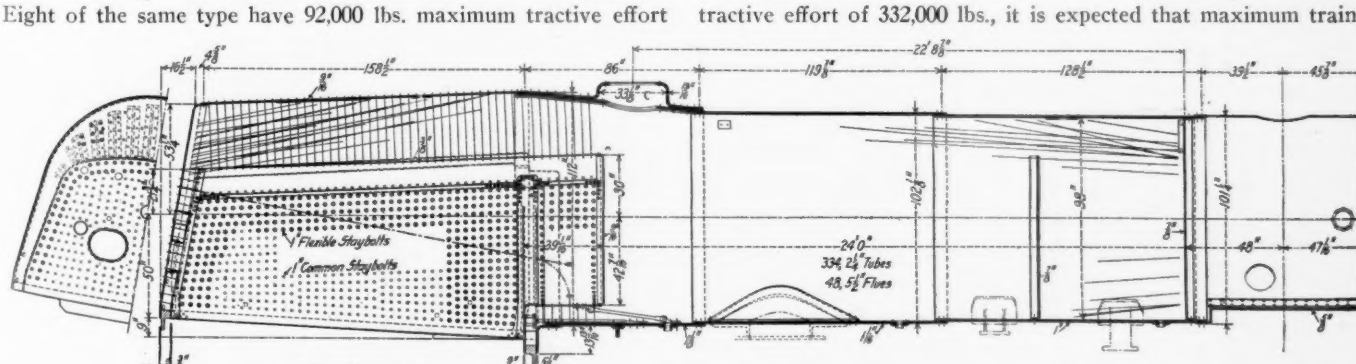
This road has had an extensive experience with Mallet locomotives, covering a period of about five and a half years. During this time a progressive series of classes of this type has been developed, each class being heavier and more powerful than the preceding one. The three classes now in service include four of the 2-6-6-0 type with a maximum tractive effort of 70,800 lbs. Eight of the same type have 92,000 lbs. maximum tractive effort and one of the 2-8-8-2 type has a tractive effort of 100,800 lbs.

The crucial point on the entire road is that portion between Elmore and Clarks Gap, W. Va., on the Deepwater division, a distance of about 14 miles. The last 11½ miles of this is on a 2.07 per cent. grade with maximum compensated curves of 12 degs. For the first 2½ miles, the grade is .5 per cent. At present, trains are usually operated over this grade with one Mallet of the lightest class at the head and two of the heavier locomotives as helpers. With this power, the maximum train over the mountain is 3,340 tons. This is approximately 500 tons less than the Mallet road engine can take over the remainder of the division.

As the road is single track and the volume of traffic is constantly increasing, it is essential to increase the maximum through tonnage and the locomotives here illustrated were developed to accomplish this without increasing the number of locomotives on each train. They will take the place of the Mallets now used as helpers which will be put into road service. With two of these locomotives as helpers and one of the class having 92,000 lbs. tractive effort at the head of the train, making a combined tractive effort of 332,000 lbs., it is expected that maximum trains of 4,230 tons over the Clarks Gap grade will be possible. The road engine, unaided, will take this train through to Princeton, the terminal of the division.

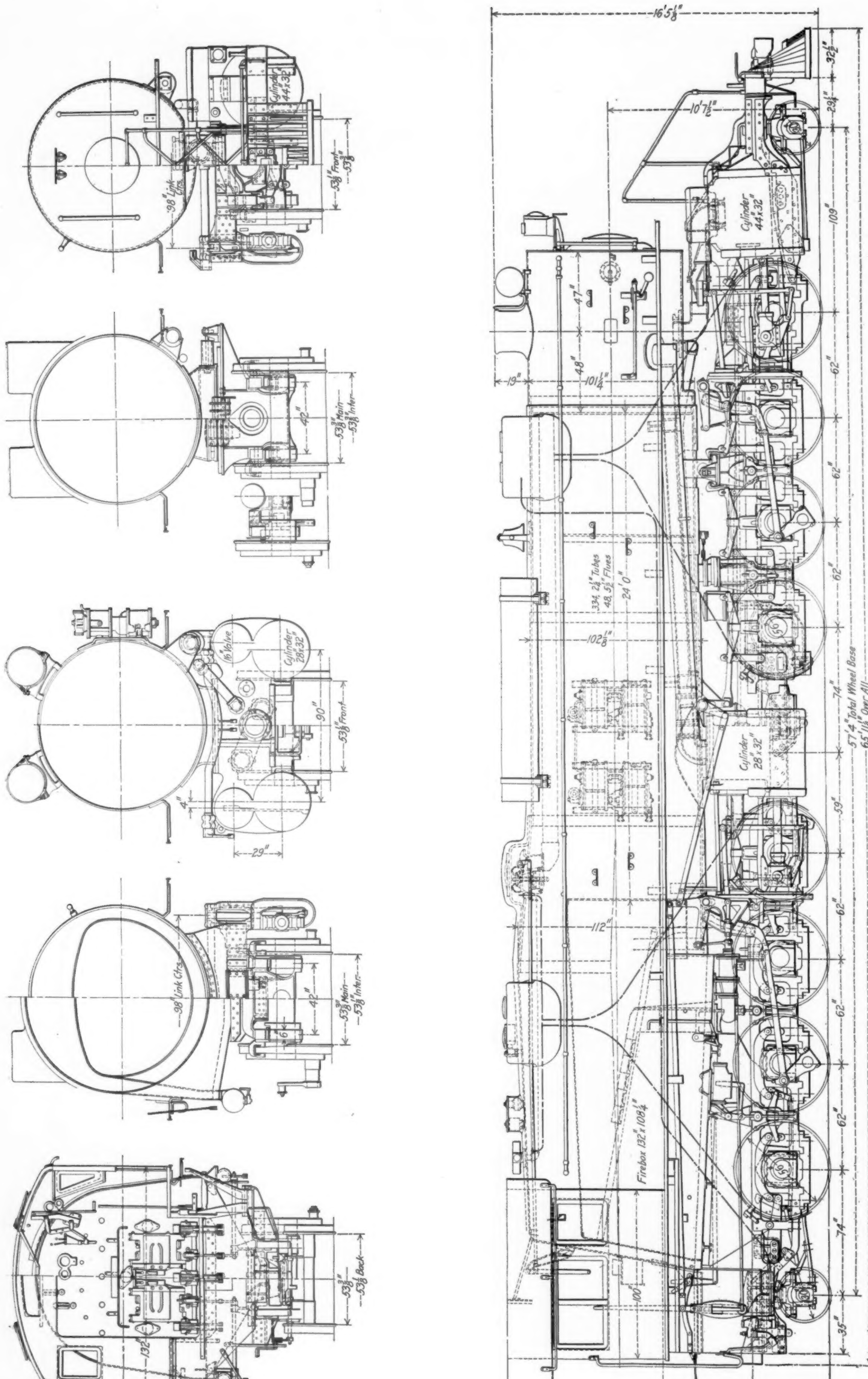


Sections of Boiler Showing Shape of the Water Legs and the Location of Superheater Flues.



Sections of the Largest Locomotive Boiler; Virginian Railway.

Apart from the great weight and power of the locomotive as a whole, the dimensions of some of the principal parts are im-



Most Powerful Locomotive in the World; Designed for Pusher Service on the Virginian; Maximum Tractive Effort, Compound, 115,000 Lbs.; Simple, 138,000 Lbs.

pressive as showing the extent to which all limits have been exceeded in its design.

Outside diameter of boiler at front end	100 in.
Outside diameter of largest ring	112 in.
Tubes, number and diameter	344—2¼ in.
Flues, number and diameter	48—5½ in.
Heating surface, total	6,760 sq. ft.
Superheating surface (inside of tubes)	1,310 sq. ft.
Firebox ring	184½ in. x 119 in.
Low pressure cylinders, diameter and stroke	44 in. x 32 in.
High pressure cylinders, diameter and stroke	28 in. x 32 in.

As far as the running gear is concerned, the design throughout represents the builder's ordinary practice. Several new and interesting features are found in the boiler, introduced to satisfactorily solve the special and difficult problems involved. One of the most interesting is the arrangement of the fire brick arch employed. This consists of a combination of the Security brick arch with the Gaines arrangement of combustion chamber. With this the most complete deflection of the gases is secured, better combustion is obtained and the back end of the firebox is more fully utilized. Not only will the special advantages of each device be obtained, but, likewise, those that are common to both will be realized to a fuller degree. Although the firebox is unusually long, the grate area is only 99 sq. ft. This is less than that provided in a number of other big Mallets recently constructed. The grates are power operated, the Franklin Railway Supply Company's power grate shaking system being applied.* They are composed of six sections and the operating system is so arranged that any one section can be operated alone if desired.

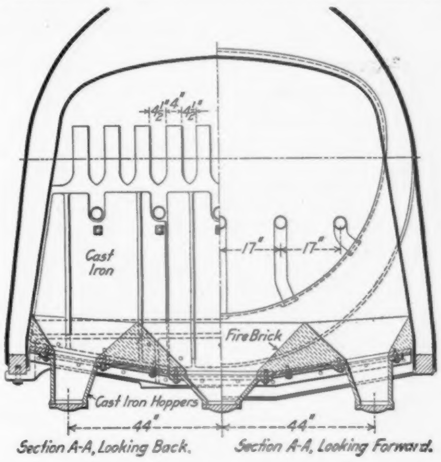
Following the latest approved practice for this type of locomotive, the engines are equipped with superheaters. The superheater is of the fire tube, double loop type contained in 48 flues 5½ in. diameter.

Vanadium steel was extensively used for those parts subjected to the greatest strain. The parts constructed of this material include the engine frames; crossheads; driving wheel tires; driving, front, trailing and tender truck springs; main driving axles, main crank pins, and piston spiders. The cylinders and valve chamber bushings are also constructed of vanadium cast iron.

Tractive effort × diam. drivers ÷ heating surface*	738.00
Total heating surface* ÷ grate area	88.00
Firebox heating surface ÷ total heating surface*, per cent	4,69
Weight on drivers ÷ total heating surface*	54.90
Total weight ÷ total heating surface*	61.70
Volume equivalent simple cylinders, cu. ft	34.44
Total heating surface* ÷ vol. cylinders	254.00
Grate area ÷ vol. cylinders	2.89

Cylinders.

Diameter and stroke	28 in. and 44 in. x 32 in.



Section of Firebox Showing Mixing Fingers on Top of Fire Brick Wall.

Valves.

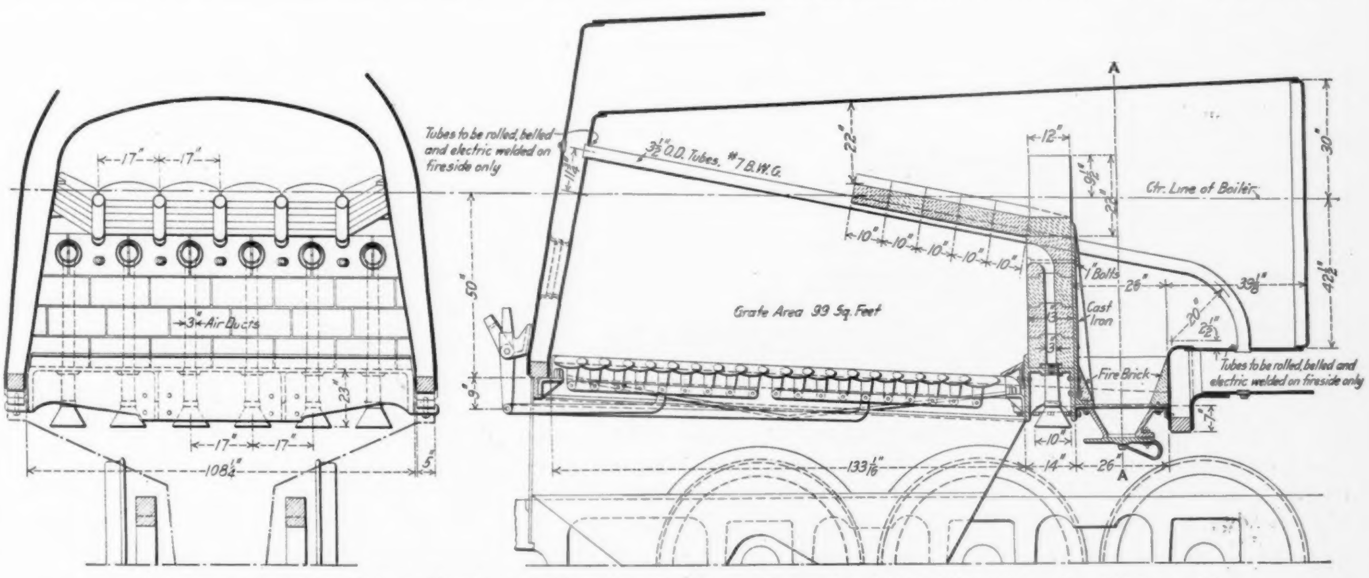
Kind	H. P.—Piston; L. P.—Slide
Diameter	16 in.

Wheels.

Driving, diameter over tires	56 in.
Driving journals, diameter and length	11 in. x 13 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	6½ in. x 13 in.
Trailing truck wheels, diameter	30 in.
Trailing truck, journals	6½ in. x 13 in.

Boiler.

Style	Conical
Working pressure	200 lbs.
Outside diameter of first ring	100 in.
Firebox, length and width	174 in. x 109 in.



Firebox of Virginian Mallets Showing Combination of Gaines Fire Brick Wall with a Security Brick Arch.

The general dimensions, weights and ratios follow:

General Data.

Service	Pushing
Fuel	Bit. coal
Tractive effort, compound	115,000 lbs.
Weight in working order (estimated)	540,000 lbs.
Weight on drivers (estimated)	479,200 lbs.
Weight of engine and tender in working order (estimated)	752,000 lbs.
Wheel base, rigid	15 ft. 6 in.
Wheel base, total	57 ft. 4 in.

Ratios.

Weight on drivers ÷ tractive effort	4.16
Total weight ÷ tractive effort	4.69

*For detailed description see *American Engineer & Railroad Journal*, October, 1911, page 384.

Firebox, water space	F.—5½ in.; S. and B.—5 in.
Tubes, number and outside diameter	334—2¼ in.
Flues, number and outside diameter	48—5½ in.
Tubes, length	24 ft.
Heating surface, tubes and flues	6,350 sq. ft.
Heating surface, firebox	410 sq. ft.
Heating surface, total	6,760 sq. ft.
Superheater heating surface	1,310 sq. ft.
Grate area	99.2 sq. ft.

Tender.

Wheels, diameter	33 in.
Journals, diameter and length	6 in. x 11 in.
Water capacity	12,000 gals.
Coal capacity	15 tons

*Equivalent heating surface equals 6,760 sq. ft. + (1.5 × 1,310 sq. ft.) = 8,720 sq. ft.

International Railway Fuel Association

Comprehensive Reports and Interesting, Active Discussion Made the Recent Annual Meeting of More Than Usual Value.

The fourth annual convention of the International Railway Fuel Association opened on May 22, 1912, at the Hotel Sherman, Chicago, with President T. Duff Smith (Grand Trunk Pacific) presiding.

After the invocation by Rev. Frederick E. Hopkins, the president delivered the opening address, using as his theme the necessity of co-operation to attain true economy. After discussing this subject from the railway standpoint as regards fuel and other supplies, he extended the same advice to the association, pointing out that in any new society, whose activities are of general interest to railway men, success for the first two or three years is assured by its newness. After reaching the point where the Fuel Association now finds itself, it is necessary to expend greater energy in all directions, if the possibilities of the idea which influenced the founders is to be developed to the fullest extent. He urged the co-operation of the members through committees, as well as individually.

Robert Quayle, superintendent of motive power and machinery, Chicago and North Western, pointed out the grave danger of permitting progress to extend to extravagance. This inclination is noticed in practically all things, and he directed his warning particularly to the danger of extravagance in the use of fuel. Much of this is easily possible to avoid, and he drew attention to many features that are not always given the prominence they deserve. It is first necessary to get good coal. There should be a carefully prepared specification, which should include the number of heat units required, on the basis of which all coal should be purchased. Inspection should be thorough and fair. He suggested the weighing of a certain percentage of the cars of railway coal regularly, in order to check the waybill weights. It is not at all infrequent to have a considerable amount of coal lost en route, either by leaking from the cars or through theft. Handling at the terminals should also be given close attention. Here, frequently, the greatest extravagance is discovered. In many cases a saving of from one to ten cents a ton is possible by improved methods of handling. He advised the members to persist in their efforts until they obtained the proper facilities. The speaker advised the use of shavings saturated with oil for starting fires, and strongly emphasized his recommendations for regular crews on regular engines, stating that this is the first essential to true economy. Grates should not be shaken more than is really necessary, which in most cases is very infrequent. He pointed out the extravagant methods of many enginemen in making station stops, and stated that, in his opinion, the air pump is one of the most extravagant parts of the locomotive. Education by leading, not forcing, was mentioned as being of primary importance. Large grate areas and the use of brick arches, which tend to greatly reduce the amount of smoke, were advocated.

Walter S. Bogle, president, Crescent Coal and Mining Co., addressed the meeting and advanced the coal operator's viewpoint of the railway fuel problem. He stated that there is a limit beyond which the coal operator cannot be expected to go in the expenditure of money for the preparation of railway fuel. At the present time, in general, the coal trade is not profitable, the average profit of all the coal operators east of the Rocky mountains being less than one-quarter of one per cent. on the money invested. Mr. Bogle said that the cost of coal to railways and other consumers is sure to increase, and mentioned several changes in conditions requiring it to do so. Among them were the safety appliance act, which has required the expenditure of over $11,000,000 in the mines in the state of Illinois during the past eighteen months; the indemnity law which is now costing the operators from 7 to 9 cents a ton of output, and the conservation law that will compel a more thorough removal of the coal from the mines. The present methods of mining are the cheapest but require the leaving of over 50 per cent. of the coal in the ground. The price of coal lands has increased over 300 per cent. during the last few years. This means, on a 5-ft. vein, an increase of about 3 cents per ton. The cost of labor has increased over 100 per cent. in fifteen years, and the higher wages are accompanied by a lower efficiency of labor.

Secretary and Treasurer's Report.—The report of the secretary-treasurer showed a membership of 406 at the opening of the convention, an increase of 39 for the year, and a balance of $1,017.30 in the treasury.

FUEL AS A FACTOR IN LOCOMOTIVE CAPACITY.

Dr. W. F. M. Goss, dean and director of the College of Engineering, University of Illinois, read a paper on this subject, an abstract of which follows: The power developed by a steam locomotive is derived from the fuel it consumes. Other things being equal, the greater its rate of fuel consumption the greater will be its capacity. The weight of the modern locomotive cannot be greatly exceeded except at the expense of extensive improvements in track or through the adoption of an arrangement of wheels which will permit the load to be much more widely distributed than at present. As it is not likely that the demand for higher power will cease, the problem of supplying it is one of more than academic significance. It presents two possible lines of solution. One is through the better adaptation of fuel to the needs of locomotive service, and the other is through the better adaptation of the locomotive to the requirements of the fuel which it has to burn.

It is obvious that anything which will successfully promote the combustion of fuel in the firebox of a locomotive will operate to increase its power. Every pound of coal effectively burned represents a definite output in the form of power at the drawbar, and if through care in the choice and preparation of the fuel the rate of combustion can be materially increased, it is evident that the maximum capacity of a locomotive may be advanced. This fact is lost sight of when locomotives performing service, in which maintenance of schedule is a matter of great importance, are supplied with coal bad in its composition and which is a mixture of the finest dust with lumps of every possible size. Conditions of service which demand high power will justify unusual care in the selection of fuels. The coal used under such conditions should have a high thermal value, and it should be low in clinker and ash. It should be sized before it is put on the locomotive tender, and if necessary it should be washed and sized. One who looks upon sized coal in a car and then upon a carload of run-of-mine coal and considers that on the grate the combustion of coal can only proceed as air can pass through the bed and around the individual particles of coal, will easily understand the superior advantages offered by the sized fuel. A principal advantage of the briquetted fuel so much used in foreign railway practice is to be found in the fact that the briquettes are of uniform size. When the coal fired is made up of pieces of uniform size, it forms a bed on the grate in which the interstices between the pieces of coal are uniform and the admission of air over the entire area of the grate is in finely divided and uniformly distributed streams. The result is that every part of the fire

is maintained in a condition of maximum efficiency; the temperature of the firebox will be higher than when mixtures of lumps and fine coal are fired; the rate of combustion will be greater, and, as a consequence, the capacity of the locomotives will be increased.

It is obvious that the power of a locomotive cannot be increased indefinitely merely through the proper selection of fuel, but the limits of its maximum performance may be materially extended. There are no objections to the general introduction of especially prepared fuel for locomotives excepting those of cost. The fuel bill of the railways is already an enormous one, and those who are responsible will always hesitate before permitting an increase in the purchase price per ton. But the ultimate cost, when measured in terms of service given, will be found in many cases justifiable. Under present practice, railways, in their desire for some increase in power, do not hesitate to increase the weight of their locomotives by giving them larger boilers, by raising their steam pressure, by the adoption of compound cylinders, and by the addition of superheaters. All of these are expensive measures, but they have been justified in practice by the results obtained. The more careful preparation of fuel is to be looked upon as a means to an end. It constitutes an embellishment in locomotive operation and is not different in purpose from embellishments in design. It will add to the expense, but will give a return in increased power which at the head of important trains may be greatly needed for the maintenance of service. I believe that a great opportunity, which as yet has been but little appreciated, lies awaiting the attention of the prophet who will proclaim the gospel of increased power of locomotives through the more careful selection of their fuels. The time is at hand when lump coal will be washed and sized, and when the fine coals will be washed and briquetted. These processes, excepting that of briquetting, are inexpensive and a demand for their employment will soon be forthcoming from the railways.

The alternative plan whereby the power of the locomotive may be increased, is that which provides for a development of its design along lines which will give it greater capacity to consume the indifferent fuels which under present practice are commonly supplied it. What changes need be made in present practice to provide a greater fuel-burning capacity? The first requisite in the development of such a design is a large grate. If a design could now be made which would permit the present maximum grate area to be doubled, several important results would at once be secured. First, while the total amount of fuel burned per unit of time might be materially increased, the rates of combustion per unit area need not be increased, they could even be reduced. The increase of power would be proportional to the increase in the total fuel burned, while the reduced rate of combustion would avoid the necessity for special care in the selection of fuel; would allow the use of fuels now normal to locomotive service; would operate greatly to reduce the loss of fuel in the form of sparks, and would prolong the period during which the locomotive could be kept in continuous operation. For example, when 6,000 lbs. of coal are burned per hour on a 60-ft. grate, the rate of combustion is 100 lbs. per foot of grate per hour, and the spark loss with many fuels represents fuel values which approach 10 per cent. of the coal fired. The collection of ash and clinker on the grate so much impedes the draft as to require a thorough cleaning of the fire after a run in passenger service of from 100 to 150 miles. A greater distance, if attempted, must generally be run at reduced power. With a large grate these conditions are all changed. The burning of 6,000 lbs. of coal on a 120-ft. grate would reduce the rate of combustion to 50 lbs. per foot of grate per hour, and the spark loss to 2 or 3 per cent., and would permit continuous operation for a passenger run of 300 miles between the cleaning of fires.

It is true that the larger grate would be at a disadvantage with reference to losses of fuel on the grate at the end of the run, and in the larger amount required to cover the grate in the process of starting fires; but these would be entirely neutralized by the possibility of increased mileage between the starting of new fires. With the larger grate, only half as many new fires would need to be made per thousand miles run as were formerly required. While the same total amount of coal is burned in each case, it is evident that the 8 per cent. saving in spark losses would at once be made available as an 8 per cent. increase of power; also that among the possible variations in the method of taking advantage of the presence of the larger grate will be included the possibility of increasing the rate of combustion. For example, an increase in the total fuel consumed from 6,000 to 8,000 lbs. an hour, would increase the power capacity of the locomotive by 33 per cent., and would involve rates of combustion which, judged by present-day standards in locomotive service, would be accounted low. If the rate of combustion were forced to a total of 10,000 lbs., the increase of power would be 66 per cent., and the rate per unit area of grate would still be below the maximum now common in locomotive service. There is, therefore, much to be accomplished by increasing the grate area of a locomotive. If the output of power remains unchanged, it will permit lower rates of combustion, a reduction of spark loss, and the use of inferior grades of fuel. If, on the other hand, the rate of combustion per unit area of grate remains unchanged, the output of power may be increased in proportion to the increase in the area of the grate.

Locomotive grates having an area of 150 ft. or more would necessarily involve some new departures in locomotive design. As the width of such a grate could not greatly exceed 7 ft., its length would need to be from 20 to 25 ft. This may mean a complete abandonment of the existing type of locomotive boiler and the substitution therefor of some new type, but it does not necessarily imply such a change. It does mean, however, the adoption of an articulated form of locomotive which will admit of a space of 25 ft. or more between the two systems of wheels. It should be possible either to increase the spacing of the frames over this space or to drop the frames so low that the firebox and boiler with attachments may have an unobstructed area the full width of the track clearance for all heights 3 or 4 ft. above the rail.

In working out details, automatic stoking must be provided for. This can best be done by having the stokers feed transversely across the boiler from both sides of the firebox. The stokers themselves may be either of the chain belt or of the Roney type, or they may consist of any simple feeding mechanism, delivering to fixed inclined grates. They would be very short in the direction of the fuel movement, probably not more than 30 or 32 in. in length, and they would discharge on a flat dump grate running the whole length from front to rear of the firebox. The aggregate width of the individual stokers on each side would, of course, be from 20 to 25 ft., but they would be split up into as many different units as would best provide arrangement, the green coal would pass under the mud-ring for the construction of short arches over them. By such an of the boiler and under a short arch, where it would ignite. It would gradually be pushed forward toward the center of the firebox to the flat dump grate, where it would be met by fuel coming in from the other side. The inward movement of coal from both sides toward the center of the grate would, of course, proceed throughout the full length of the firebox, that is, for a distance which might be as great as 25 ft. The fact that the ignitions of the fuel would be under an arch would make the combustion nearly or quite smokeless, the mild draft would make the cinder losses small, while the low rate of combustion per unit area of grate, and the provisions for cleaning supplied by the stokers and dump grate, would permit continuous operation at full power for a very long period.

Narrow hoppers supplying these stokers would open up along the whole length of the firebox on both sides to the full width allowed by the track clearances. The operating mechanism of the stokers, which would be beneath them, would be allowed the same total width. An extension of these hoppers upward on both sides to the level of the top of the boiler or higher, would provide space for all the coal necessary for a run. No coal would be carried on the locomotive tender and none would need to be rehandled on the locomotive. It would all be loaded at once into an extension of the stoker hopper, and its weight would be added to the wheel loads of the locomotive.

In the discussions of the preceding paragraph, I have assumed that the general type of boiler employed would not be materially different from that now in service. Difficulties would, of course, appear in the construction and maintenance of a staybolt firebox 25 ft. in length, and whatever the outside form of the boiler might be, some special provision would need to be made in the working out of its construction. A demand for a firebox of such dimensions would doubtless call out various means for supplying it. There would probably be no difficulty in constructing a Jacobs-Shupert firebox of any desired length. The boiler would be so located on the frames of the locomotive that its back-end would be just in advance of the first of the rear system of driving wheels, and a foot-plate carrying all of the auxiliary machinery of the locomotive would extend rearward over the axles of these rear wheels and perhaps over the wheels themselves. A fire door, as usually placed, would supply the fireman an opportunity to inspect his fire, and guided by such inspection he would be able to so control the operation of the several stokers as to maintain uniform conditions throughout the length and breadth of the grate. The barrel end of the boiler would extend out over the forward system of wheels. So much for the arrangements involving a normal boiler. If it should be desired, an attempt could be made to work out the details of the design, using an entirely new form of boiler, such, for example, as a boiler of the water-tube type; but it is not likely that the adoption of any such new type would of itself simplify the general problem as herein outlined.

In conclusion, permit me to say that I appreciate thoroughly the danger of attempting within the limits of a few paragraphs to outline successfully a locomotive design that is entirely new. I appreciate also the many difficulties to be met in applying any such conception. I cannot even claim that I have yet given the matter such attention as will permit me to say that all difficulties are surmountable, but I am convinced that the general scheme is sufficiently promising to justify any study which is likely to be bestowed upon it. My purpose in presenting it is to place before the members of this association in as forceful a way as possible, the importance of larger grate areas in locomotive practice. If the capacity of locomotives is to increase in the future as it has in the recent past, and if locomotives are to be supplied with such grades of coal as are now commonly used in locomotive service, such a change will be found imperative.

Discussion.—A general agreement with the author's arguments in favor of better prepared fuel was evident, but there was considerable skepticism as to the feasibility of the practice under present conditions. The advocation of larger grate areas on locomotives met with the approval of most of the speakers. One member suggested that it was not so much larger grates that are needed as larger firebox volumes.

H. B. MacFarland (Santa Fe) drew attention to the primary importance of boiler capacity in the locomotive, stating that, in a majority of cases, it was necessary to rate locomotives entirely on their boiler capacity. An opinion was expressed by W. E. Symons that the locomotive proposed was not far from present-day requirements. In that connection he drew attention to the design, recently patented by G. R. Henderson, having three groups of drivers, one being under the tender. He also reminded the members of the proposal of the late E. H. Harriman to use a 6-ft. gage. This was advanced largely for the purpose of permitting the use of locomotives of greater capacity. A continental system for this gage had been outlined, and while the scheme was at present lying dormant, it was not entirely improbable that the requirements of the near future might again bring it to life.

C. A. Seley (Rock Island) stated that, although the suggested locomotive might seem radical, past history indicates that suggestions of this kind quickly become conservative and it should not be thrown aside on this account.

T. R. Cook (Pennsylvania) spoke briefly about locomotive stokers and their relation to increased locomotive capacity. Stokers handling a much larger amount of fuel than would be possible with hand firing are now in use and, taken in connection with other boiler capacity increasers, have put the present possible locomotive capacity considerably beyond anything considered feasible even a few years ago.

E. McAuliffe (Frisco) suggested that the permanent way would require considerable alteration if the larger locomotives were to be introduced. Even with the present Mallet locomotive it is frequently impossible to operate the locomotives efficiently because of the condition of the permanent way.

R. Emerson related his experience with burning soft coal on the large grate areas of locomotives designed to burn anthracite. Three difficulties appeared. The first is that the heat thrown off from the large fuel bed makes the fireman's work very difficult. Again, the amount of fuel to be put into the firebox is practically beyond the capacity of one man, and third the very thin fire which must be maintained in order to permit the air to pass through the fuel bed. He followed Dr. Goss' prophecy by suggesting an articulated locomotive in three parts. One group of drivers would carry the combustion section of the boiler, the second the evaporating section, and the third would be devoted to feed water heaters, etc. Another suggested development was the placing of a power house on wheels at the head of the train, which would generate electric current to be transmitted to the electric tractor cars scattered throughout the length of the train, possibly one for each ten cars. A fertile field for investigation was mentioned by the speaker in the use of powdered coal mixed with about 10 per cent. of oil. Such a combination gives great heat, and experiments had indicated its practicability.

LOCOMOTIVE FUEL PERFORMANCE SHEET.

Robert Collett, superintendent of locomotive fuel service of the St. Louis & San Francisco, presented a paper on this subject in which he described the locomotive fuel performance sheet used on the Frisco, and also summed up the replies to a circular letter which had been sent to the members of the association.

A little more than a year ago, the St. Louis & San Francisco decided to try out, on one division of 250 miles, an individual engine daily performance sheet. Formerly a monthly performance sheet had been kept, but this had been discontinued about three years previous, because the information was more or less inaccurate and reached those interested so late that it was not considered worth the expense of compilation.

It was the opinion of the general officer who originated the later plan, that if sufficiently close supervision could be given to all of the separate features, a correct daily record of each engine's performance could be obtained and that with this information, as well as a knowledge of what constituted good average performance in each class of service, a good idea could be obtained as to what each of the engines were doing and should do in the use of fuel. Accordingly, a daily performance sheet, such as shown herewith was started and sufficient time was spent on one division to get in thorough touch with all the

details of its operation. Later the plan was put in effect on all other divisions.

At first all of the compilations were made daily, but it was found that it was not necessary to figure out the number of pounds used per car mile or per thousand ton miles each day, but the tonnage for car miles, fuel, hours of service, and, where the engine made only a single trip, names of engineers, are set down daily and the person handling the report can thus locate conditions and including coal used in getting engines ready for the trip. It was early found by experience that merely taking the daily reports and tickets, as furnished, did not fulfill the requirements, as considerable carelessness was manifested in making coal tickets and making up daily fuel reports, and, by accepting reports as made out, an engine might consume 500 lbs. of coal per thousand ton miles one day and 50 lbs. the next, or none at all. One instance is recalled where an engine

LOCOMOTIVE FUEL PERFORMANCE; COAL AND FUEL OIL

DIVISION ______________ MONTH ______________ 191___

Eng. No.		Date															Total & Avg.	Date																Total & Avg.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
	Class of Service																																	
	Pass. Car Miles or 1,000 Gross Ton Miles																																	
	Locomotive Miles																																	
	Tons Coal or Gallons Oil Used																																	
	Lbs. Coal or Gals. Oil Used per Pass. Car or 1,000 G. T. M.																																	
	Number of Hours in Service																																	
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	Tons Coal or Gallons Oil Used																																	
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	Number of Hours in Service																																	

Individual Engine Daily Performance Sheet; St. Louis & San Francisco.

unreasonable performance. A recapitulation is made of each engine's performance at the end of 15 days and at the close of each month. This constitutes the daily record, and from this is made, on typewriter, a monthly report, which is the performance of each engine on the division, in each class of service; from the reports from each division a general report is compiled

As a basis for what constitutes good average performance, numerous records of trips have been made, taking every-day was charged with 24 tons of coal during a 24-hour period, while being held in for work; the engine was not fired up during that time, and on this account, of course, other engines were not charged with the actual coal they received. This instance is mentioned to show the close attention necessary to be given this feature. The clerks or fuel foremen, handling daily fuel reports, do not always realize the importance of correct information.

It is a hard matter to convince the average person handling

REPORT OF HANDLING OF LOCOMOTIVES FROM ______________ ROUND HOUSE

For 24 Hours Ending Midnight ______________ 191___

Engine Number	Arrived Ash Pit				Fire Knocked				Time Offered				Time Ordered				Time Fired Up				Time Ready				Time Under Steam		Mech. Delay		Trans. Delay		Remarks.
	Day	Hour	Min.	A.M. or P.M.	Day	Hour	Min.	A.M. or P.M.	Day	Hour	Min.	A.M. or P.M.	Day	Hour	Min.	A.M. or P.M.	Day	Hour	Min.	A.M. or P.M.	Day	Hour	Min.	A.M. or P.M.	Hour	Min.	Hour	Min.	Hour	Min.	

AVERAGE DELAY ENGINES UNDER STEAM ______ Hrs. ______ Mins. ______

AVERAGE MECHANICAL DELAY ______ Hrs. ______ Mins. ______

AVERAGE TRANSPORTATION ______ Hrs. ______ Mins. ______

______________ Round House Foreman.

INSTRUCTIONS

This report must be made out the first thing every morning, sending a copy to Master Mechanic, Superintendent and General Superintendent.

This report is to cover all engines handled. They should be separated on the report; that is, all passenger engines should be shown together, then your preferred freight power, then chain gang and then switch. Engines tied up for more than 24 hours' work are not to be charged under Mechanical Delay.

When Round House Foremen require 2 hours' notice, transportation delay does not begin until two hours after engine is offered. For instance, if offered at 4:00 P. M. for 6:00 P. M., there is no transportation delay, but if ordered for 7:00 P. M. there would be transportation delay of one hour.

Special Terminal Report on Locomotives; St. Louis & San Francisco.

fuel station reports that it is not necessary for him to arbitrarily change the amount shown on the ticket in order to keep his balance somewhere nearly correct, but that the matter should be regulated with the party delivering the fuel to the locomotive. Likewise, it was found difficult to reconcile the average ticket furnished by the engineer with the amount of coal delivered to the engine as shown by scale weight, although the coal might be weighed immediately before being placed on the chute. The fact that this distribution requires such close supervision makes a daily record, in our opinion, desirable.

If performance sheet is kept, is it an individual engine record or engineer's record of fuel consumption? Replies indicate that one method is in use about as much as the other. Some members prefer both the engineer and engine record and are handling it in this way. Our opinion is that the engine record is preferable to the engineer's record, for the reason that we should have tickets to cover the individual trip. In freight service it sometimes happens that the engine will be handled by more than one crew in going over the division, and it is not possible to separate the fuel used by each crew; again, an engine may run over more than one division, handled by two separate crews, not taking any fuel at the intermediate terminal. Where engines are manned by regular crews, this report practically becomes an engineer's record also.

While the operation of the engine does have a great deal of bearing on the fuel consumption, the condition of the engine also is important and where it is necessary to rely to some extent on the engineer's estimate, as at chutes where a night force is not employed, the engine record, we believe, best serves the purpose. The waste due to the condition of the engine is apt to be as great as that due to improper operation, and it is necessary to have the enginemer's co-operation in obtaining this information, both as to the condition of the engine and the amount of fuel used, while the waste due to improper handling or firing is more a matter of education through personal contact than through the medium of the performance sheet. The least skillful man is most likely to give a short ticket or cultivate the good will of the chute tender, to the engineer's advantage perhaps and to the discredit of another man who is really more economical in the use of fuel. Whereas, if it is an engine record, for each division, it reflects to a large extent the condition of the locomotives and is for, or against, the division mechanical officers. One division cannot be altogether checked against another division, but records of service tests on that division should also be used for comparison.

What is your opinion as to separating the fuel used at the terminal from that used on the trip? The opinion of those replying were almost equally divided, many objecting to the accounting necessary to separate the charges and taking the view that as it must necessarily all be charged to locomotive operation, nothing could be gained from the separation. A great many thought it unfair to charge crews with the fuel used at the terminal over which they had no control.

We do not attempt to separate the fuel used in firing up the engine from that used on the trip, but do undertake to give credit for the fuel used over and above the amount required to fire the engine up and which may be consumed by lack of facilities or other causes. This has been taken care of by a special terminal report, which has taken the place of a report formerly used to show the time engines were in terminal and the mechanical and transportation delays. This has been changed to include the time that engines are held under steam at terminal. All time in excess of three hours that the engine is fired up is shown as terminal delay and credit is given on the basis of a certain number of pounds per hour. This amount is deducted from the fuel used by all engines.

What methods are used to interest enginemen in economical performance? Class meetings are held on the different divisions, as often as convenient to interest the enginemen in fuel economy. They are not only attended by enginemen, but others who may care to attend, together with all of the officers that can be present. All points involved are discussed freely, suggestions and criticisms are invited, and division and system performances are gone over, so that all may be advised of the progress being made. Separate educational meetings are held with the firemen. While special effort is made to have the accounting as correct as possible, we depend more on personal contact than writing to the enginemen to obtain results. On divisions where the crews have regular engines, mimeograph forms are sent out at the close of each month, advising the engineer of the amount of coal consumed by him and the pounds per passenger car mile or the pounds per thousand gross ton-miles for freight trains and the average for all engines in that class of service. Information from the daily performance sheet is furnished the proper officers, who take the matter up personally with the crews. Crews are also complimented by letter for good performance where it comes under the personal observation of master mechanic or assistant superintendent locomotive fuel service; copies of these letters are frequently attached to the enginemen's personal record. Monthly bulletins are posted by the superintendents calling attention to what has been done on their respective divisions as shown by the division fuel statement, thus encouraging renewed effort.

Do you consider the extra expense of scales in mechanical chutes advisable? The majority of the replies indicated that scales are not in general use, about one-half favoring their use in connection with the fuel performance sheet, and several advising that experience with scales had proved unsatisfactory.

On our lines there are a number of mechanical chutes, only two of which are provided with scales; also several gravity chutes holding from 200 to 300 tons, with no means of measuring the coal delivered to each engine; a few pocket chutes which have been calibrated and stencilled in ton measurements; several locomotive cranes and at some points we shovel direct from the car to the engine tank. Our experience has been that the most accurate distribution is by using the billed car load weights as a guide, taking the fuel foremen's or hostlers' estimate, and requiring them to observe the space in the tank. We find they become very familiar with the amount of coal that is required to fill a given space. All coal is weighed on our railway track scales after leaving the mines and special attention is given the feature of correct weights. Fuel oil tanks are provided with calibrating rods, stencilled in gallons. We do not use meters at our fuel oil stations. On a recent 30-day test of a Mallet locomotive, the hostler's estimates of coal taken from a mechanical chute at one end of the line and a fuel foreman's estimates at an intermediate pocket chute station, showed a difference of but 1.22 tons when compared with the amount recorded by the man making the test. This case is unusual, but serves to illustrate that a reasonably correct charge can be obtained.

In the opinion of the writer, scales are not necessary at terminal points, unless engines of foreign lines are to be coaled. Our observation leads to the belief that unless the person assigned to that duty has nothing to do but look after the scale, or if a large number of engines are handled, the weighing is apt to resolve itself into guess work, due to certain engines taking coal and the chute men not being at the scale at the time.

At intermediate coaling stations, if the chute is located at a pumping station where a night man is employed, or if there is enough work to justify the employment of two men to operate the chute, I believe the scale is desirable, as it does not represent any additional cost for operation and gives a better distribution than that made by relying upon the engineer's estimate.

We do not undertake to include an adjustment in the per-

formance sheet for the difference between coal chute measurements and the billed weights, but make a special effort to have the amounts shown tally as closely as possible with the fuel actually used. All concerned know that it is to their interest to have this shown; for if all the fuel used is not charged in any particular month, it will be reflected in the poor performance the following month when the error has been corrected.

The work on each division is under the direct supervision of the assistant superintendent locomotive fuel service, who formerly held the position of road foreman of equipment and who has practically the same duties, giving special attention, however, to the matter of fuel economy. The number of engines assigned ranges from 70 on the lightest to 130 on the heaviest division.

The handling of the performance sheet requires the services of one clerk for each division, and unless the division is a very heavy one, he can also handle the correspondence.

No extra expense is incurred in procuring data on tonnage, car miles, hours of service, etc., this being furnished on the report made up in the despatcher's office for the car accountant's records.

Too much emphasis cannot be given the matter of correct distribution. No greater mistake can be made than to assume, with the posting of a bulletin requiring correct fuel tickets to be made out or the installation of weighing or measuring methods, that the problem of distribution is solved. A little first hand experience will soon dispel this illusion. Nothing will cause an engineman to lose faith in a performance sheet more quickly than to find that some person handling the fuel report is changing tickets to suit his own convenience, while on the other hand, a sincere effort to give every one a square deal will meet with a very hearty response.

Some details which have had an influence in keeping up interest and also helped reduce the fuel bill, are as follows: Weekly reports submitted by the fuel inspectors on the condition of the flooring of coal cars placed for loading at the mines; a monthly report showing the diameter of the exhaust nozzles of each engine; a crusade on the overloading of engine tanks at coaling stations; waste at the coal chutes, and deck guards on engine tanks to prevent the coal wasting at the gangway.

Discussion.—The author's proposed forms drew but little favorable comment. There was a somewhat general criticism on the absence of any record of the performance of the engine crew. The advisability of attempting to maintain any record of this kind was questioned on the ground of its known inaccuracy due to the many indeterminate factors.

Several methods, using different forms than those proposed, were described by members, and particularly by G. M. Carpenter (N. C. & St. L.), who stated that the fuel department organization and methods as used on his road (234 locomotives) were very successful, although they possibly might not be as well suited for a larger road. The methods included the careful calibration of the coal space in the tender, and when a locomotive came in from its run the amount of coal left in the tender was recorded on the proper form. The amount then put on was recorded, and the crew starting out with the locomotive was charged with the total amount. From this would be deducted the amount remaining at the completion of the run. Daily reports were made and the fuel performance of the engineers and firemen were recorded as well as for the locomotive. Each coal chute had both a night and day foremen and the coal spaces in the chute were carefully calibrated. The foremen were responsible for the records.

Mr. McAuliffe drew attention to the items on the sheet used by Mr. Collett which showed the amount of time required for cleaning fires and stated that a very excellent check on the quality of the fireman's work can be obtained by a knowledge of the length of time it takes to clean the fire on his engine. He strongly advised the use of personal effort with the engine crew, claiming it to be of much more importance in obtaining fuel economy than the use of any type of performance sheet.

R. Emerson advanced the opinion that unless the performance sheet can be accurate in every particular to at least within a few per cent. it is of no value. To do this so many factors must be taken into consideration that it would be very difficult to properly keep the records, and therefore performance sheets as now maintained, or as they can be maintained in the future, are useless. He described the system used on the Eastern Railway of France, this being the only one he knew that approached perfection. On this road all trains are scheduled and the same locomotives with the same crews are regularly employed. These conditions could not be duplicated in this country, and even the refinement there obtained would not be possible here.

Mr. Collett, in closing his paper, stated that he was not in favor of the calibrated fuel space in the tender recommended by Mr. Carpenter.

ANTHRACITE COAL FOR LOCOMOTIVE FUEL.

T. S. Lloyd presented a paper on this subject in which he recommended the use of anthracite coal on suburban, transfer and yard locomotives, in spite of its high cost, in order to abate the smoke nuisance and offset the movement for electrification.

Discussion.—Although it appears that the use of anthracite coal on locomotives, in general, is decreasing, as a means of reducing the smoke from yard and transfer engines and reducing the justice of the demand for electrification in urban districts, its value was generally recognized by the association. Several members testified to success in this direction. T. W. Brewer, for example, stated that the Lehigh Valley was using anthracite extensively and that all things considered, on yard engines, it was the cheapest fuel because of the absence of criticism from municipal governments on account of the smoke.

R. Emerson quoted from reliable statistics showing that five per cent. of the locomotives in the United States use anthracite coal and 5 per cent. use oil. The governing factor in the use of anthracite on road engines is whether the coal can be sold more profitably for domestic purposes. Anthracite in prepared sizes is sometimes used in passenger service for reasons other than economy. Special fireboxes are not required for burning anthracite on yard engines. As an alternative, coke has been suggested, but the difficulty of firing coke makes its use improbable. While briquettes are possibly a more suitable fuel than coke, the cost of briquetting is an objection which will probably delay its adoption. In emphasizing the importance of the reduction of smoke to avoid electrification he gave a brief outline of the cost of the latter and showed that no economy can be expected from electric operation.

PROPER METHODS OF FIRING LOCOMOTIVES.

D. C. Buell, chief of the educational bureau on the Union Pacific, Illinois Central, Yazoo and Mississippi Valley and Central of Georgia, presented an individual paper on the Proper Method of Firing Locomotives, in which he covered, more or less thoroughly, the entire field of fuel economy.

Is it not fair to assume that the reason we fail to get better results along the line of attempted fuel economy on railways is due to the fact that we have been working along the wrong lines? Is it too much to admit that our efforts are not based on sound principles, and that we need to discard the old and begin anew to work out this problem on basic principles, the following out of which must, from the nature of things, bring results?

Drastic measures seem to be necessary, and if statements in this paper appear harsh or radical it should be remembered that the object is not to criticize present practice, but to cause an awakening as to fundamentals—the better understanding of which will be necessary before any great improvement over present practice can be expected.

The army of combustion experts who are fighting for fuel economy center their attacks on the locomotive fireman. Books,

lectures, chemical demonstrations, road demonstrations, premiums, bonuses, and a thousand and one other things, are hurled at the fireman in a vain endeavor to make him burn the fuel more economically. Nevertheless the proper firing of a locomotive is an art known and practiced by but a small percentage of the locomotive firemen of today. The onslaught on the fireman has been so fierce, that in the smoke of battle many of those attacking this problem have entirely lost sight of the fundamentals which are beyond the control of the fireman, and consequently cannot be remedied by him. The proper training of the fireman to fire according to correct principles of combustion is but one of the steps leading to the solution of the problem of fuel economy on a railway.

Proper Grade of Fuel.—The officers of most roads have recognized the importance of a knowledge not only of the heat value per pound of the different grades of fuel available on their roads, but also of other properties of coal, such as whether it clinkers, how much ash it contains, its coking or caking properties, etc. Still another factor is determining what grade of a certain coal can be used most economically; that is, whether it is more economical to use mine-run, or the higher priced screened coal. The traffic department and the operating department must be consulted to make sure that, as far as possible, the interests of the company may be served well in the selection of the fuel to be used. The dependability of the mine in working steadily and turning out a uniform grade of fuel is also a factor. After the proper grade or grades have been determined they should be regularly used so that locomotives may be properly designed and drafted to burn the fuel furnished them economically; and so that the men can familiarize themselves with the proper handling of the class of fuel furnished to them.

Inspection.—Proper inspection of coal at the mines is just as essential as the inspection of locomotives or cars built for the company. Inspection should be made for both quality and weight.

Distribution.—The economic distribution of the fuel from the mine to the point used is one of the big items of fuel economy. I venture the assertion that on roads where this matter is not carefully handled, as much money is wasted through this channel as by improper firing. It is an operating matter pure and simple, and deserves a most careful study. A few years ago, J. G. Crawford, of the Burlington, worked out very complete statistics along this line and presented his results in a paper before the Western Railway Club.*

In this connection the direction of the volume of traffic must be considered, so that the company coal can tend to balance the tonnage instead of throwing it further out of balance. Other factors are the reduction of mileage of empty coal cars, the tonnage that can be hauled over ruling grades, etc.

As an example of what can be accomplished, it has been found economical on one of the transcontinental lines to haul a large quantity of company coal from mines in the far west to eastern terminals, and store it there for a time, the reason being that at certain seasons the traffic is almost entirely westbound. Then coal cars are needed east. These cars can be loaded at the mines, hauled east by power that otherwise would run light; the coal can be unloaded and stored and the cars released where wanted; all at an expense that is negligible compared to what it would cost to keep those eastern terminals supplied at a later season when the traffic was nearly balanced or heavier eastbound.

Coaling Stations.—There is an astounding variation in the cost of coaling locomotives. Cost may vary from two or three cents a ton at a modern link-belt station, to 25 or 30 cents a ton at some more primitively equipped plant. One road that I know of arranged with a company that makes a specialty of erecting coaling stations to finance the erection of a number of stations on its line. This road in a short time saved enough on the cost of coaling engines to not only pay interest on the capital invested for them, but to pay the principal as well.

It is safe to say that a master mechanic or road foreman in territory where this item of cost has not been carefully supervised could save more money, save it more quickly and make the saving permanent, by reducing the cost of coaling engines than by a campaign among his firemen.

Waste at Terminals.—It is ridiculous to talk fuel economy to a fireman, when the road foremen, roundhouse foremen, or master mechanics will allow them to bring engines in from a trip with a ton or more too much of unburned fuel in the firebox—practically all of which is wasted when the fire is cleaned; and when, at this same terminal, hundreds of pounds more fuel are wasted keeping fires in engines that are allowed to pop off around the yard or in the engine house, or in rekindling fires. Such little economies (where they are economies) as the kindling of fires with oil and shavings make the fireman realize that coal is a valuable commodity, and set him thinking about how he can save some.

Condition of Locomotives.—There is nothing more discouraging to a good fireman than an engine that will not steam properly. But a poor steamer seems to have some hypnotic effect on a poor fireman or a new man that not only causes him to forget everything he has ever heard or known about the correct principles of firing, but suggests that he is no longer a fireman—merely a coal-heaver—and he acts on that suggestion. The average man, overtaken by the feeling that he has a good excuse for making a failure, fails with ease. The man to heed fuel economy talk is one who knows that the boiler plant of his locomotive is in good condition.

Stop Steam Leaks.—It is folly to delude ourselves into thinking that the fireman of today is stupid or weak-minded enough to listen with attention to either orders or pleading about economical firing when the engine he fires wastes more steam than he wastes coal. The waste of steam mentioned in this connection includes not only the steam that is wasted past piston and valve glands, packing rings, valve rings or seats, etc., but that steam which is wasted from poor valve setting, excessive engine friction, etc.

Accounting.—The accounting for fuel on most roads is a joke. There are but few, if any, of you in this room, connected with the motive power department of a railway who do not know of the pencil adjustments made every month at each coal chute to balance the tons of fuel charged against that point. This adjustment has become such a common-place affair that the engineers and firemen know of it. Then how can we command their respect if we talk about proper firing of an engine to produce fuel economy, when they know that we can't come within from 50 to 300 tons per month of balancing our fuel accounts at different coaling stations?

Common Sense Statistics.—How do you know whether or not a fireman is firing economically? What statistics have you to prove it? Our ideal is maximum work at the drawbar with a minimum number of heat units. Our performance sheets at the best show only inconclusive comparisons. Pounds of coal per thousand ton miles on a water level division and on a 2 per cent. are totally different propositions; and even comparing the same class of engines on the same run we fail miserably because we have no accurate method of checking the amount of coal issued to an engine, nor of knowing the amount left on the tank at the end of the run. Neither do we credit the fireman with the coal consumed while the engine is at the terminal.

On some roads every one of these items is receiving careful attention and good results are being accomplished. It is probably safe to say that on every road one or more of these items is the particular hobby of some officer and, therefore, is closely watched.

My object in calling attention to this matter has been to defend those hundreds and thousands of loyal men who are daily

*See *American Engineer*, April, 1908, page 124.

striving against staggering odds to get their firemen to fire locomotives properly. The reason that road foremen, master mechanics, fuel experts, combustion experts—call them what you may—have not been able to get permanent results has, to my mind, been due in most cases to the overwhelming odds they have had to work against.

Proper Firing.—The proper method of firing a locomotive is the logical method for all firemen to follow, for the simple reason that it is the easiest, the least laborious, and most satisfactory method. If an engine is fired properly there are fewer scoops of coal to be handled, little or no necessity for using the rake or slicebar, or of cleaning the fire; and the shaking of the grates is reduced to a minimum. In addition to this, an engine that is fired properly steams, unless there is something radically wrong with the engine, or the coal is devoid of heat units. But even in such a case proper firing produces the most steam possible under the conditions; and the fireman may safely feel that no one could have done better than he did under the circumstances.

In order to fire an engine properly the fireman need not necessarily know anything about the theory of combustion—he may have learned to apply the principles without knowing the reason for so doing. In fact many first-class firemen do not understand anything about these principles. There are, however, certain fundamental facts that should be borne in mind when endeavoring to explain to firemen the necessity of doing certain things to get proper results. To produce heat in a locomotive firebox three conditions are necessary—and only three: First, there must be a supply of fuel. Second, there must be a plentiful supply of air, and third, the air and the fuel must be brought together at a temperature at which they will burn.

Soft coal is composed of coke and gases. When a shovelful of this coal is thrown on a fire the gases are driven off by the heat, the coke remaining on the grates. Both the coke and the gases will burn, but before any burning can take place they must be supplied with air at what is called the igniting temperature. Air is made up of several gases, one of which is the particular thing required for burning the coke and the gases in coal. This burning will not take place until the fuel and the air are heated to a certain temperature, called the igniting point.

With the three conditions of fuel, air and proper temperature present, burning will always take place, but with any one of these three conditions lacking, burning absolutely will not take place. When burning does take place, the fuel disappears, with the exception of the ash and the dirt that were in the coal, and these remain on the grates. This disappearance of fuel is due to the fact that in the process of burning, a chemical change takes place by which the air and the fuel unite to form gases; these are drawn out through the flues into the front end, and from there pass out through the stack with the exhaust. During this changing process, the heat necessary for steam-producing purposes is evolved.

While there are many different kinds of fuel which may burn in many different ways, any one who thoroughly understands the basic principles set forth above can understand and explain most of the actions that take place in a locomotive firebox.

In describing the actual work of firing a locomotive, it is necessary to assume that the engine is properly drafted, and is in proper condition to burn economically the fuel furnished; and in the discussion which follows it is assumed that these conditions exist.

In starting out, the fireman should endeavor to have a light fire, a level fire, and a bright fire. These three conditions should always exist in the firebox. The thickness of the fire should be regulated by the class of fuel, the drafting of the engine, and the weight and schedule of the train. The fire must be light because the amount of air that can be supplied in a locomotive firebox is always limited.

If the fire is too light, the draft will pull such a large volume of cold air through it that the temperature of the gases will be reduced below the igniting point, and proper burning will not take place. This condition can be ascertained by observing the fact that the steam pressure immediately falls under such conditions, and no smoke appears at the stack, even when fresh fuel is thrown on the fire. If the fire is too heavy, however, it is not so easy to recognize the condition, although proper results cannot be obtained with a thick fire. It is practically impossible to get sufficient air through a thick fire to properly burn the large volume of gases that are liberated from the fuel, and the result is, that when fresh fuel is thrown on the fire, although there is sufficient heat in the firebox to drive off the gases from this fuel, there is neither the proper igniting temperature present nor the requisite air supply to burn them. These gases, however, as soon as they are liberated from the coal, are pulled through the flues by the exhaust, and as the conditions in the firebox have not been such as to allow them to burn, and as these gases are the principal heat-producing part of the coal, it will readily be seen that a large amount of heat is wasted.

The fire must be level for the reason that in an engine properly drafted, there is an equal pull of air through the entire grate area; but, if the fire is banked at one place and low at another, the air, seeking the easiest channel for entrance, will for the most part pass through the place where the fire is light, very little air passing through the place where the fire is banked. This gives an unequal distribution of air to the fire, and creates the same effect on one part of the fire as though the draft were too light, and on the other part as though it were too heavy. This is further and better illustrated in cases where there is a hole in the fire. In such cases nearly all of the air passes through the hole, and very little through other parts of the fire, with the consequent result that the steam pressure immediately responds to this condition; and the pressure cannot be regained until the fire is leveled over, and the proper conditions for burning are once more obtained. A condition of this kind is very hard on the boiler, as well as on the steam pressure.

The fire must be bright, because it is absolutely necessary at all times to keep the temperature in the firebox up to the igniting point of the gases. Burning will absolutely not take place untained in a locomotive is about 2,500 deg. Fahr.; the igniting temperature of the gases is about 1,800 deg., so that there is but comparatively little range between the maximum temperature that can be obtained, and the point at which the gases will not burn, due to the temperature in the firebox being below the igniting point of the gases. Burning will absolutely not take place unless this igniting temperature is present; and the three cardinal principles of the light fire, the level fire, and the bright fire, must be kept constantly in mind in order that the fuel can be properly burned.

With the fire in this condition, fresh fuel should be added in comparatively small amounts at regular intervals. The fresh fuel should be spread on the bright spots, and the fire door should be swung shut, or closed, after each scoopful of fuel is added.

There are two important reasons why fresh fuel should be added to the fire in comparatively small amounts. In the first place, opening the fire door to add fresh fuel allows a considerable quantity of cold air to enter the firebox, thus reducing the firebox temperature; and this fresh fuel must be "torn down" into its elementary constituents before burning commences, which absorbs considerably more heat. If it is desired to deaden a fire, it is covered over with a large quantity of fresh fuel; if fuel is added to the fire in large quantities it, in like manner, cools down the temperature of the firebox, perhaps below the burning point, with the result that although the temperature is lower than that at which the gases will commence to burn, nevertheless, a considerable amount of gas is driven off from the coal even at this lowered temperature. The result is that much of the heat possible to be obtained from these gases under normal conditions is lost because the gases are pulled through the flues and out of the stack, without having had an opportunity to burn. On

the other hand, had the coal been added in comparatively small quantities, the temperature would have been maintained at the burning point. The second important reason is that, with a large amount of fuel added to the fire at one time, such a large volume of gas is given off that even were the temperature of the firebox maintained at the burning point, it would be impossible to supply sufficient air to mix with these gases to properly burn them.

The fact that fresh fuel should be placed on the bright spots in the fire can readily be understood, because where the fire is brightest, the fuel is nearer to being consumed, and, consequently, fresh fuel is required at that point. The fact that the fire is not bright in some places in the box, indicates that there is a supply of fuel at those points that is not yet burning at the highest heat (in some cases this might indicate a hole or a clinker, but either of these will readily be detected) and that those points, therefore, do not require more fuel until the burning becomes further advanced. There is an old rule which says that "If a fireman takes care of the sides and the corners, the center will take care of itself." This, while not true in all cases, is well to remember.

As regards swinging, or closing, the fire door between each scoopful of coal, it can readily be seen that if this is not done, the firebox temperature will be reduced. Closing the door between each scoopful of coal gives an opportunity for the temperature to be maintained at the burning point.

With the engine in proper condition, it is an easy task to fire according to correct principles and get economical results; but, when engines are not in a condition that will permit firing them as just described, a much more difficult proposition confronts the fireman. The same general principles, however, hold true, although the fireman must use his practical experience and good judgment to get the best possible results under the conditions which exist.

Prevention of Smoke.—Some years ago the single scoop method of firing was advocated as a cure-all for smoke troubles. Experience has proved that with the modern large locomotive single scoop firing is not satisfactory in most cases, although there is seldom a time when more than three or four scoopfuls of fuel should be used for a fire. With a fire in the proper condition a fireman will produce but very little smoke if he carries a light fire, a level fire, and a bright fire, adding but three or four scoopsful of coal to the fire at a time needed—spreading the coal over the bright spots and closing the door between scoops. This refers to unnecessary black smoke, and not to that smoke which will be formed at certain times and under certain circumstances, no matter what the condition of the engine is, or how careful the fireman may be.

In approaching stations, the summit of grades or other places where the engine will be shut off, the fire should be burned down sufficiently so that when the engine is shut off very little smoke will be produced if the blower is "cracked" slightly. In adding fuel to the fire while at stations, if the coal is placed along the sides of the firebox and in the corners, and a bright fire is left in the center of the box, most of the smoke will be consumed when the blower is opened a little way, and the fire will be spread by the exhaust when pulling out of the station.

Prevention of Clinkers.—Almost any fire can be clinkered by stirring it up with a hook so that green coal gets down on the grates. A fire can also be clinkered by shaking the grate so hard that green coal works its way down through the fire. With some classes of coal, heavy firing which causes banks to form in some portions of the fire will start a clinker. When a clinker has been formed in a firebox it can sometimes be broken up by shaking the grates with short, quick jerks, but as a general rule in order to get rid of it the fire must be cleaned. Trouble due to clinkered fires can be materially reduced by not shaking the grates so hard, not using the hook or slice-bar so often, and by careful firing to prevent the formation of banks in the fire.

Wetting Down Coal.—The first principle about wetting down coal is to use as little water as possible. Dusty coal should be sprinkled lightly so as to keep the dust out of the cab. Fine coal or slack should be wet just enough to hold it together after it is thrown into the firebox until it cakes or cokes; otherwise this fine coal will be pulled straight through the flues by the exhaust without having touched the fire or having an opportunity to burn.

Breaking Up Coal.—Coal should be broken to about the size of a man's fist before being fired. This allows it to be spread more evenly over the fire and also allows the coal to burn faster than it will when fired in big lumps.

Shaking the Grates.—With a fire that has a tendency to clinker the grates should be shaken with sharp quick jerks, but with a coal that does not clinker it is advisable to shake the grates easily so as not to disturb the fire any more than necessary. The grates should be shaken just enough to keep the fire clean. The question as to when the greates should be shaken depends upon the class of coal being used, and no general rule can be given covering this.

Popping.—It has been demonstrated that with the ordinary pop valves as much heat is wasted each minute the pop is open as is contained in from three to six ordinary scoopsful of coal. There is absolutely no excuse for this wasteful practice.

Drumming.—Drumming can be stopped by closing the dampers, putting fresh coal on the fire, or making a hole in the fire. In other words, by changing the conditions so that the mixture of the air and the gases is changed from what it was while the drumming was being produced.

Systems of Firing.—A great many systems of firing have been advocated from time to time—single scoop firing, cross firing, banking and other methods. All that it is necessary to say concerning these different systems is that any system is good which follows the correct principles of combustion.

Firing Poor Steaming Engines.—There are a great many causes why an engine may not or will not steam. The one cause which is most frequently given, however, is the one that least often exists, namely, poor coal. Most of the cases of engine failure which are reported as due to poor coal are due to other causes, although there are many legitimate cases where the heat value in a certain tank of coal is not sufficient to make steam fast enough for the needs of the run. In such cases all that can be done is to fire according to correct principles so as to get the greatest possible amount of heat out of this poor coal. If an engine does not steam and the fireman is satisfied that he has done all he can do to build up and keep a proper fire in his engine, he should then examine the front end to see if there are any air leaks, the ash pan to see if it is full, the dampers to see that they are properly adjusted, the ash pan netting to see that it is not stopped up, the grates to see that they have not become clogged with clinkers and dirt. He should examine the flues to ascertain whether they have become honeycombed over or stopped up; and if none of these causes is present and there seems to be a good draft in the firebox and no leaking flues he should experiment with his fire, building it up heavier if he does not get much smoke at the stack, as he may be getting too much air through the fire; or letting it burn down lighter if large volumes of smoke appear at the stack, as the fire may be too heavy. If none of these things effect a remedy, there is probably something wrong with the engine or the manner in which it is being handled.

It is an easy matter to tell, as has just been done, how to properly fire a locomotive, but the problem of getting firemen to fire that way is a totally different matter.

***Educating the Fireman.*—So far as I know there are only three ways by which firemen can be brought to a realization of the importance of the subject and lined up so as to actually fire their engines properly, even when not under the eye of some one in authority. The first of these methods is by personal instruction and demonstration right on the deck of the engine during a**

trip. The second is a combination of instruction by lectures, or otherwise, at the terminal and an accurate check of performance by an observer on the engine. Both of these methods are, comparatively speaking, expensive, and both require considerable time in which to accomplish any appreciable results.

The third method is by offering premiums or bonuses to enginemen and firemen for economy in the use of fuel. This method, however, is as a rule unsatisfactory on account of the lack of a proper system of accurately checking the results. The plan in practice seldom is fair and this causes dissatisfaction.

With all due respect to those advocating other methods I must say that my experience has been that such other methods accomplish only the minimum in the way of results. Their only recommendation is that they keep the subject alive and that in some cases they are so economical that if they do any good at all they more than pay for themselves. Classed in this latter category are combustion lectures, circulars and bulletins, instruction books, etc.

The ideal plan is to have a bright young engineer or an experienced fireman appointed as traveling fireman. Each traveling fireman should be able to handle successfully about a hundred engines, if not spread over too wide a territory. These men should not be assigned permanently to one particular territory, but should be moved from division to division or from district to district about once in 30 or 40 days so that they will be kept wide awake by the new surroundings and new problems they meet; and, in addition, so that they won't get calloused to improper local conditions, nor so well known to the engineers and firemen that familiarity will breed contempt for their instruction. These men should be more or less familiar with the principles of combustion, should be able to take the scoop away from the fireman at any time or place and fire the engine successfully, and should be able to explain, and in simple language, the principles they recommend and demonstrate. There are many such men in engine service on every one of our railways today.

With a crew of this kind reporting to the general road foreman of engines or to the superintendent of motive power of a road which is awake to the other conditions required to produce the ideal of fuel economy, such a crew of men should be able to pay a yearly dividend on the investment represented by their salary and expenses of from 500 to 1,000 per cent. or more.

The second plan that can be worked out successfully is through the agency of a first-class fuel man, who understands thoroughly the practical side of locomotive work, and in addition is well posted on the theory of combustion and the science of fuel economy. This man should be able to handle the problem on a road having not over 750 engines. He should be a good talker, should be equipped with statistics, charts, stereopticon and lantern slides, and perhaps with a very simple chemical outfit for demonstrating purposes, and, if he is right up to date, with moving pictures. He can be furnished with a car if extra equipment is available; or he can cut down his outfit and simply travel from roundhouse to roundhouse. He should have sufficient official standing to command the respect and co-operation of road foremen and master mechanics. Arrangement should be made so that all firemen would have to attend his talks at least once every 60 days.

This much alone, however, will not accomplish the desired results. He should have under him two or three bright apprentice boys equipped with a little pocket counter, a pail, and a small spring scale. He should keep these boys on the road all the time riding engines. The duties of these boys would be to count and keep record of the number of scoops of coal fired between stations. By means of the pail and scale and a little horse sense they could weigh four or five test scoops of coal to determine the average weight per scoop of coal fired. The boys' records should include the engine number, names of engineer and fireman, the kind of coal, number of cars in the train, the tonnage of the train and the weather conditions, and alongside the column showing station names and the number of scoops of coal fired, the time of leaving, arriving or passing the stations, including a record of the time the engine was standing at intermediate stations. The record should also show the number of times the engine popped off and approximately the number of minutes the pops were open; and, in addition, the number of times the grates were shaken, a record of the use of the rake or slice bar and memorandum of anything out of the ordinary regarding the condition of the engine or the method or running or firing it.

The fuel man, with these boys assisting him, is now in a position to have an accurate up-to-date check of actual performance to use in connection with his talks and demonstrations. From the very first the records that the boys obtain show up conditions that get both engineers and firemen interested. The data collected soon show that some men are going over the road and shoveling several tons less coal than other men, and the knowledge of proper methods gained from the lectures combined with a determination to do as well as the other fellow starts more men to firing according to correct principles.

The reason why both of these plans are successful is that both demonstrate to the fireman that the proper method of firing a locomotive is the easiest and least laborious method for him to follow. It seems impossible to make him believe this by talking alone, no matter what arguments you bring to bear.

When conditions do not permit either of these plans being put into effect and the premium or bonus plan is not considered practical, about all that remains to be done is to put as forceful a circular or instruction paper as can be written on the proper method of firing, letting master mechanics and road foremen follow the matter up as thoroughly as time will permit.

There are, of course, special cases where other methods may be worked out; for example, the moving pictures are to be used by the educational bureau on the Central of Georgia for the instruction of the colored firemen. It is also the intention of the Union Pacific Educational Bureau to put a plan into effect to break in the new firemen that are hired on the road as we now do men entering station service—the method would be a combination of class-room instruction and student trips on the road, both under the supervision of an experienced instructor. This method of breaking in will take no longer than the present method but should start the man in with proper ideas and correct habits instead of in the present hit or miss fashion.

An appendix to Mr. Buell's paper contained the instructions for firing with oil which have been issued by F. F. Gaines, superintendent of motive power of the Central of Georgia.

Mr. Buell's paper was illustrated with stereopticon views, including a large number of moving pictures which admirably brought out the effect of good and bad firing on the production of smoke. The presentation of these lantern views occupied a large part of Thursday afternoon's session. Some of the moving pictures represented two freight locomotives hauling a heavy train over quite a distance on a grade. Views were taken with the camera on a car ahead of the engines so as to show the engine from the front, and others were taken from a rear car to show the amount of smoke which is made by bad firing and to the annoyance of passengers in the observation car. Other moving pictures showed the firemen actually at work, one of them firing properly and the other producing lots of smoke by bad work.

Discussion.—The moving pictures used for demonstrating the proper method of firing to the firemen employed on the Central of Georgia were thrown on a screen for the benefit of the members. Mr. Buell explained the object of each film and the way in which it would be used. Films showing a complete firebox but without side sheets, so that the movement of the coal after it left the scoop could be observed, were shown. In these, a fireman was demonstrating the proper and improper method of handling the

scoop and the effect of each. Other films showed a good fireman working on a pusher engine and a poor fireman under the same conditions. All the bad practices of a fireman were demonstrated and the appearance of the stack and steam gage indicated their result. Another film showed two platforms by the side of a large locomotive which was popping. Coal was transferred from one platform to the other at the same rate it was being wasted through the safety valves. The size of the pile after five minutes was surprising. Other films showing a double header on a heavy grade were thrown on the screen. One locomotive had a good fireman and the other a poor one. The amount of smoke and the raising of the safety valve on closing the throttle for a flag clearly indicated the good results of proper methods.

General commendation of Mr. Buell's methods marked the statements of the members discussing the subject.

H. T. Bentley suggested that Mr. Buell's paper be printed and offered for sale. He would like to have sufficient copies so that all of those interested on his road could be furnished with one. As an instance of the result of the fireman's work he also mentioned the length of time it requires to clean fires. He had seen at one point as much as two hours needed to clean the fire of a locomotive and it frequently required over one hour. After discussing the subject with the fireman and closely following up the matter, it now required not over 20 minutes under the worst conditions. The work of the fireman frequently affects passenger traffic, the public not caring to travel on trains where there is excessive smoke. Mr. Bentley spoke strongly of the practice of shaking the grates, stating that it is not at all necessary. He explained that a study of the methods used by T. E. Adams on the St. Louis and South Western had taught him many things of importance about proper firing.

W. H. Averell (B. & O.) said that in connection with educational work among the firemen on his road he had appointed five supervisors of locomotive operation whose duties are to show all division officers, including operating as well as motive power, how they can assist in fuel economy. These men point out the methods of improvement and afterwards follow the matter up and see that their suggestions are being carried out. The division officers themselves authorize the changes. The methods used are, in general, the ordinary ones, and after one year's work along these lines it was found that there was a reduction of 12 per cent. in the cost of coal. Mr. Averell expressed the opinion that savings of this kind can usually be made by the regular organization, if their attention is properly drawn to the subject and the best methods are clearly placed before them.

F. W. Foltz (Mo. Pac.) reported on the operation of locomotives over a certain section of track used jointly by the Missouri Pacific and the St. Louis South Western. The same coal is furnished the locomotives of both roads, but on the former there were frequent engine failures, and a check in one case showed that over this section of the road the grates were shaken nineteen times and the ashpan was cleaned twice. Under the same conditions the locomotives of the latter road would go over the division without shaking grates or cleaning the ashpans. By careful attention and the use of Mr. Adams' methods of firing he had been able to cure the trouble and had also reduced the average time of fire cleaning from 47 minutes to 15 minutes. He spoke very highly of Mr. Adams and his method of firing. Other members who had studied the system used on the St. Louis South Western spoke strongly to the same effect.

LOCOMOTIVE DRAFTING AND ITS RELATION TO FUEL CONSUMPTION.

H. B. MacFarland, engineer of tests, Atchison, Topeka and Santa Fe, presented a lengthy and elaborate paper on this subject, an abstract of which follows:

The idea of drafting a locomotive for efficiency is seldom considered, or if considered at all, is only of a secondary consideration. The principal object is good steaming. The object of this paper is to present information showing results of our present method of drafting engines rather than to show slight variation in results by slight changes in various pieces of apparatus relative to one another. A further object is to present information and data that will, in some great degree, obviate the troubles of our present system of drafting by throttling low pressure steam.

In order to determine the relative efficiency of the front end drafting arrangement of the various principal classes of locomotives in use on the Santa Fe, both passenger and freight, a number of tests were made and complete data bearing on the subject secured. The efficiency of the front end has been commonly defined as the ratio of draft in inches of water per pound of back pressure in the cylinders. Although a few scientific investigations have been made relative to the subject of locomotive drafting, any exhaustive study of the subject of back pressure in the cylinders produced by creating draft with the exhaust jet has been quite generally neglected.

The art of making an engine a good steamer, if it may properly be termed an art, consists largely in haphazard, cut-and-try methods. As an instance of the lack of uniformity in drafting arrangements it may be cited that for twenty locomotives of the same class, operating on the same district in similar service, and using oil as fuel, the diameter of the nozzle varied from 5⅞ in. to 6¼ in., and yet all of these engines were considered good steamers. It may be further stated that these twenty locomotives were constructed by the same builders from the same designs and patterns and were supposedly alike in all respects.

The tests described were made on different divisions of the Santa Fe where conditions of operation are such that they represent the most severe demands made upon power, as well as power working under normal demands in average service. The data collected concerning the drafting arrangements typically represents the various methods employed for making an engine what is known as a "good steamer."

The simple adjustment of a petticoat pipe or diaphragm plate will often convert a poor steaming engine into a good steamer by causing an equalization of draft between the top and bottom flues, or the front and back portions of the firebox, or else will so change the action of the exhaust jet in the stack that a greater draft will be created. When an engine is once made to steam freely, no further consideration is given to front end adjustments regardless of the fact as to how uneconomical such an arrangement may prove as regards fuel consumption, water consumption, etc. The main consideration of those charged with locomotive operation is to get the engine in such shape that it will steam freely on the road and get its tonnage from terminal to terminal with least delay. And yet the theory of drafting by means of the exhaust jet is so uneconomical and productive of such great thermal losses and energy losses, due to back pressure on the cylinders, that any saving which could possibly be effected by minor adjustments within the smokebox would have but small bearing upon the total fuel cost.

The simplest and most effective way to increase the draft and produce a good steaming engine is to reduce the size of the exhaust nozzle. This reduction is accomplished by use of either a bushing or a bridge in the nozzle tip. Although this method of securing increased draft is easily understood by the men directly charged with getting the locomotive in operating condition, few realize the tremendous tax such an arrangement is upon the effective power of the engine.

The results of the tests show conclusively the price a locomotive pays in fuel and power, due to drafting with the exhaust jet. There is a general impression that some power is lost on account of back pressure, yet it is not recorded that this is any considerable per cent. of the power developed by the locomotive. The results of these investigations show that the potential energy lost, due to present method of drafting locomotives is very considerable, not only in actual amount but in percentage of total power of the locomotive.

The back pressure, due to any given sized nozzle, was found in these tests to be practically the same in the cylinders of a com-

pound locomotive as a simple locomotive, yet the power loss is much greater for the compound engine than for the simple engine, due to the greater area of the low pressure piston. This power loss is then in the ratio of the area of the low pressure piston of the compound engine to the area of the pistons on the simple engine, all other conditions being equal.

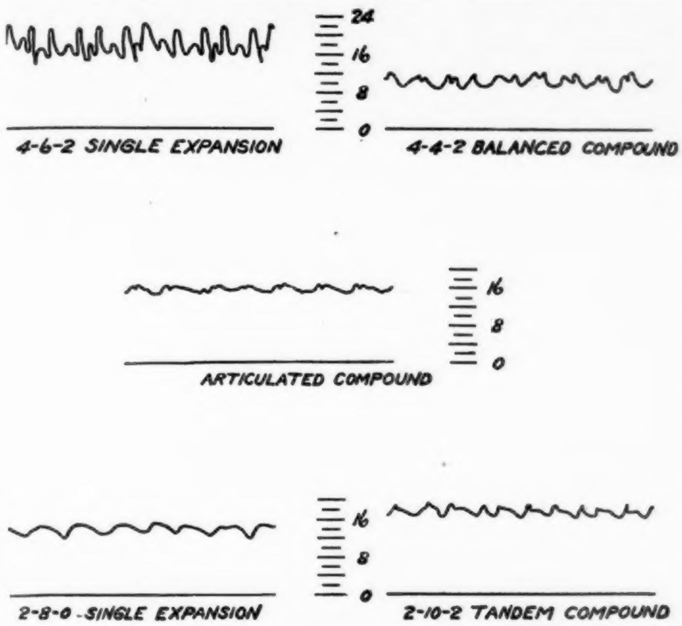


Fig. 1—Typical Exhaust or Back Pressure Cards.

As this back pressure is acting against the piston, it can be computed as actual horsepower developed, but not utilized. When computed in this manner it is found to amount to from ten per cent. of the total available power of the engine at low speeds to over 50 per cent. of the total available power at high speeds. This condition holds true with both ordinary freight and passenger engines, but for Mallet engines the losses are much greater.

The locomotives tested, eighteen in all, were operating over the divisions to which they are regularly assigned. No special care was given to the selection of an engine, the object being only to secure an engine that would typically represent a certain class and type. An endeavor was also made to secure engines of the same type burning oil for fuel on one territory and coal for fuel on another territory, in order that the results secured might be comparable in so far as oil and coal-burning locomotives were concerned. Each engine was in regular service with its ordinary rated tonnage and was operated by its regular crew, no special instructions being given relative to its operation, so that results obtained would reflect those obtained under average operating conditions. A sufficient number of observations were made to cover completely all the varying conditions in speed on the grades over which the locomotive was operated.

Draft readings were taken at the side of the smokebox just ahead of the diaphragm plate. The draft gages used were of the usual "U" tube water column type, reading in inches of water. The back pressures in exhaust steam, due to the restrictions caused by the nozzle tip, were determined with an ordinary Crosby steam indicator using a 20-lb. spring. The pressure reading was taken in the exhaust cavity of the valve, the indicator being attached to a ½-in. pipe within the cavity. The pressure was determined within the exhaust cavity of the valve rather

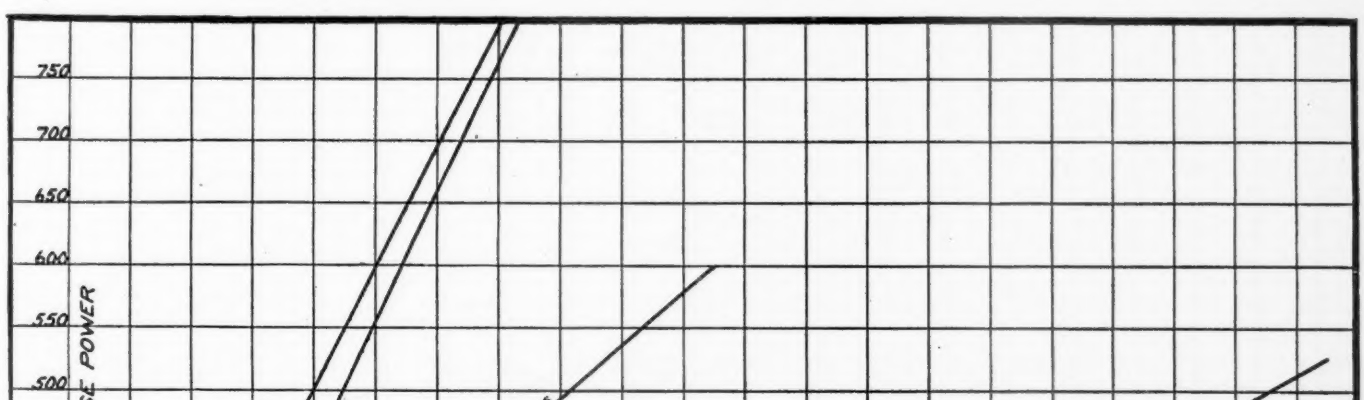


Fig. 2—Curves Showing Back Pressure Horse-Power at Speeds in Miles Per Hour.

than at the exhaust tip, in order that the pressure of the steam, which was acting directly against and retarding the action of the pistons, would be secured. Typical exhaust cards secured from both simple and compound locomotives under different conditions of operation are shown in Fig. 1.

[The results obtained in the tests of each of the eighteen representative locomotives, plotted on charts along with diagrams of smokebox arrangement, general characteristics of the classes of engines and a photograph of a representative locomotive of each class were included in the report but are not reproduced here.]

The wide variation in drafts and exhaust pressures between locomotives in passenger and freight service, as well as Mallet locomotives in heavy freight service, may be seen by reference to the general summary of results shown in Table 1, and must be attributed to the peculiar conditions of operation, grade characteristics, and other purely local circumstances.

TABLE 1.—GENERAL SUMMARY OF RESULTS OF TESTS.

Engine.	Drafts. Aver.	Exhaust Pressure. Aver.	Back Pressure Horse Power at—			
In Passenger Service:			20 m. p. h.	30 m. p. h.	40 m. p. h.	50 m. p. h.
1299	9.7	12.6	185	240	295	350
1273	8.6	14.7	175	230	285	340
1262	9.3	11.4	140	290	440	590
1304	9.1	10.0	130	200	270	340
1205	11.5	16.2	155	250	345	...
1416	11.6	9.2	75	155	235	315
1490	5.8	10.2	115	185	255	325
In Freight Service:			10 m. p. h.	15 m. p. h.	20 m. p. h.	25 m. p. h.
1636	7.7	10.8	130	280	430	580
1647	6.5	10.4	160	250	340	430
843	7.2	12.5	150	225	300	375
1964	10.8	11.2	65	130	195	260
1817	5.5	7.3	65	105	145	185
985	10.6	13.5	120	210	300	390
1069	7.9	11.7	130	170	210	250
3002	10.3	16.5	300	550	800	1,050
3200	15.9	14.4	235	490	745	1,000
1700	11.3	11.2	290	385	480	575
1180	14.3	12.1	170	310	450	590

No specific analyses should be made of coal and oil-burning locomotives of similar type, owing to the fact that the oil-burning locomotive is generally operated or presents opportunity for operating at a much higher capacity than the coal-burning locomotive, due to the fact that the fuel used affords an opportunity for increased steam production.

A general study of the results shows that the back pressure remains practically constant at all speeds, indicating that the back pressure depends upon the volume of steam passing through the exhaust nozzle regardless of the speed of the locomotive. The draft, then, is dependent upon the intensity and velocity of the exhaust jet and not on the speed. Any increase in volume of steam passing through the exhaust nozzle in a unit of time increases the intensity and velocity of the exhaust jet and causes a corresponding increase in draft.

Since the back pressure remains practically constant for any increase in speed, it necessarily follows that the back pressure horse power is the only variant and must increase in direct ratio to the speed. The back pressure horse power curve, then, is a straight line, and a formula may be developed for each class of locomotive which would enable one to compute the back pressure horse power for any given speed in miles per hour.

In order to get the general relation in back pressure horse power for the various locomotives tested, the back pressure horse power for each engine has been plotted on one general chart with reference to miles per hour and is shown in Fig. 2. (General dimensions of the locomotives are given in Table 2.)

A study of this chart will show the wide variation in loss due to back pressure between Mallet, freight, and passenger locomotives. As a general rule, it may be stated that the horse power loss, due to back pressure, at any given speed, is least for passenger and greatest for Mallet locomotives.

In order to get a comparison of back pressure horse power for all types of locomotives, curves have been plotted showing the back pressure horse power on a basis of cubic feet of piston displacement per minute. This chart (Fig. 3) is based on the cubic feet of piston displacement per minute of one cylinder only. On compound engines the low pressure cylinder value only was used. A study will show that the back pressure horse power for all of the locomotives tested follows the same general law. A general formula may then be developed to express the back pressure horse power loss for any given locomotive.

TABLE 3.—CONSTANTS FOR BACK PRESSURE HORSE POWER PER MILE PER HOUR IN SPEED.

Passenger Service:	
1270 & 1297	— B. P. H. P. = 7.4 x m. p. h.
1270* & 1297*	— B. P. H. P. = 6.6 x m. p. h.
1200	— B. P. H. P. = 5.6 x m. p. h.
1226	— B. P. H. P. = 9.3 x m. p. h.
1400	— B. P. H. P. = 6.4 x m. p. h.
1485	— B. P. H. P. = 6.9 x m. p. h.
498	— B. P. H. P. = 6.7 x m. p. h.
500	— B. P. H. P. = 7.2 x m. p. h.
1309	— B. P. H. P. = 10.0 x m. p. h.
Heavy Freight Service:	
825	— B. P. H. P. = 16.3 x m. p. h.
985	— B. P. H. P. = 12.0 x m. p. h.
900 & 1600	— B. P. H. P. = 21.3 x m. p. h.
1950	— B. P. H. P. = 12.0 x m. p. h.
Fast Freight Service:	
1069	— B. P. H. P. = 9.9 x m. p. h.
1800	— B. P. H. P. = 10.5 x m. p. h.
Mallet Service:	
1180	— B. P. H. P. = 27.0 x m. p. h.
1700	— B. P. H. P. = 36.0 x m. p. h.
3002	— B. P. H. P. = 37.3 x m. p. h.
3200	— B. P. H. P. = 35.3 x m. p. h.

*Bushed cylinders.

TABLE 2.—DIMENSIONS OF THE LOCOMOTIVES TESTED.

Engine. No.	Class.	Fuel.	Weight. Pounds.	Tractive effort. Pounds.	Kind.	Stack. Diam.	Nozzle. Diam.	Petti-coat pipe.	Over-draft. Inches.	Under-draft. Inches.	Working pressure. Pounds.	Total heating surface. Sq. ft.	Area of tubes. Sq. in.	Grate area. Sq. ft.
1299	4-6-2	Oil	240,550	36,000	Simple	18	6	14	5	2	200	4,069	883	48.0
1273	4-6-2	Oil	234,600	36,000	Simple	17½	5¾	0	0	0	210	4,243	883	49.5
1262	4-6-2	Oil	226,700	32,800	Bal. Comp.	15½	5½	14	6	1	220	3,595	938	53.5
1304	4-6-2	Coal	240,550	36,000	Simple	17½	5 11/16	14	8½	8	200	4,069	883	48.0
1205	4-6-2	Coal	216,100	33,600	Simple	16	5¼	14	6	6½	220	3,595	938	53.5
1416	4-4-2	Coal	204,100	22,200	Bal. Comp.	15½	5¼	11	15	2	220	3,206	883	49.5
1490	4-4-2	Oil	231,675	23,600	Bal. Comp.	15	5⅝	14	7	½	220	3,673	883	48.0
1278	4-6-2	Oil	234,600	36,000	Simple	17½	5 5/16	0	0	0	200	4,243	883	49.5
1276	4-6-2	Oil	234,600	36,000	Simple	17½	6	0	0	0	210	4,243	883	49.5
498	4-6-0	Oil	181,900	31,800	Simple	....	5 5/16	....	....	....	210	3,112	851	50.5
500	4-6-0	Oil	181,900	31,800	Simple	....	5 3/16	....	....	....	200	3,112	851	50.5
1316	4-6-2	Coal	276,500	35,000	Bal. Comp.	....	5¾	....	....	....	210	4,131	1,160	57.6
1636	2-10-2	Oil	287,240	62,800	Tandem Comp.	17¾	5⅞	14	4	2	225	4,796	1,265	58.5
1647	2-10-2	Coal	287,240	62,800	Tandem Comp.	19	5¾	13	15	3½	225	4,796	1,265	58.5
843	2-8-0	Coal	199,250	43,200	Tandem Comp.	16	5	0	0	0	210	2,961	883	48.0
1964	2-8-0	Oil	212,400	49,500	Simple	17½	5¾	12	9	10	180	3,750	883	47.3
1817	2-6-2	Coal	248,200	40,300	Bal. Comp.	17	5¼	12	13½	8½	225	4,020	1,106	53.7
985	2-10-2	Oil	276,960	60,470	Simple	17½	6	14	13	1	225	5,616	1,265	58.5
1069	2-6-2	Coal	210,190	34,700	Vauclain Comp.	16	5½	14	12	4	220	3,185	1,028	52.1
1962	2-8-0	Oil	212,400	49,500	Simple	17½	5¾	....	....	....	180	3,750	883	47.3
898	2-8-0	Coal	263,400	47,700	Simple	17½	5¾	....	....	....	160	6,186	1,852	58.5
901	2-10-2	Coal	306,950	62,800	Tandem Comp.	17½	5⅝	....	....	....	225	6,807	1,265	58.5
917	2-10-2	Oil	292,140	62,800	Tandem Comp.	17½	6½	....	....	....	225	4,796	1,265	58.5
923	2-10-2	Coal	287,240	62,800	Tandem Comp.	17½	5¾	....	....	....	225	4,796	1,265	67.0
3002	2-10-10-2	Oil	616,000	110,000	Mallet Comp.	17½	6½	16	6	2	225	8,958	1,220	81.9
3200	2-8-8-0	Oil	391,500	96,000	Mallet Comp.	17½	6	14½	2	3	200	7,233	883	47.3
1700	2-8-8-2	Oil	462,450	108,000	Mallet Comp.	20½	7	16	9	3	225	8,419	1,253	70.4
1180	2-6-6-2	Coal	370,200	68,000	Mallet Comp.	17½	5⅞	14	8	6	220	6,191	951	54.0

B. P. H. P. = cubic feet piston displacement per minute times a constant. The constant is one-tenth for passenger and freight service, one-eighth for heavy freight service, and one-sixth for Mallet service.

This formula, when transferred from cubic feet piston displacement to miles per hour, gives a constant of value in considering any class of engines. The results for the different classes of engines tested are given in Table 3.

The efficiency of the drafting arrangement in the front end is generally expressed as the ratio of inches of draft to pounds of exhaust pressure. Table 4 has been prepared to show this efficiency for the different engines. Maximum and minimum conditions refer to the maximum and minimum draft produced during the performance of the engine.

TABLE 4.—EFFICIENCY OF FRONT END.

Showing inches of draft per pound of back pressure with various conditions of draft.

Engine No.	Condition with Draft: Maximum.	Minimum.	Average.
1299	0.70	0.82	0.78
1270	0.55	0.63	0.58
1226	0.72	0.85	0.81
1297	0.90	0.93	0.91
1200	0.62	0.90	0.71
1400	0.97	1.14	1.42
1480	0.52	0.63	0.57
1636	0.70	0.80	0.70
1647	0.58	0.67	0.62
843	0.56	0.57	0.58
1964	0.97	1.40	0.93
1817	0.70	1.00	0.73
985	0.86	0.71	0.79

General charts have been prepared and are presented to show the relation between back pressure horse power, the indicated horse power and the drawbar horse power. The observations were taken from actual tests made on different types of locomotives, both in freight and passenger service, both coal and oil burners. These curves are plotted with horse power as ordinates, and miles per hour as abscissae.

The chart shown in Fig. 4, was prepared from data secured in the test of a single expansion Mikado type locomotive in mountain service between La Junta and Trinidad, Colorado. The full lines show the back pressure horse power, indicated horse power, drawbar horse power and mean effective pressure.

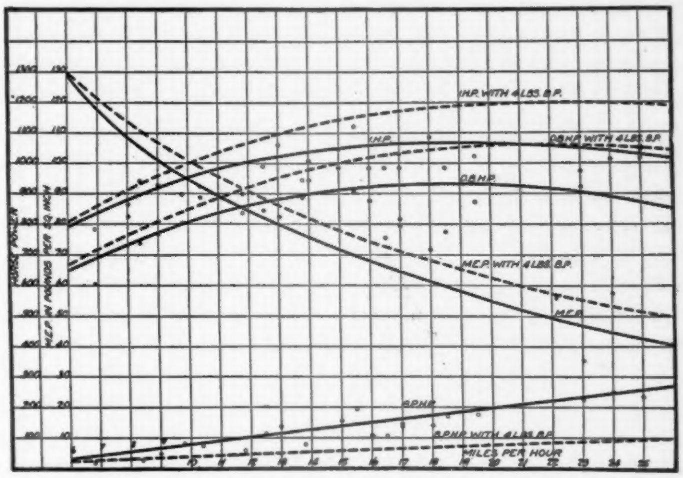
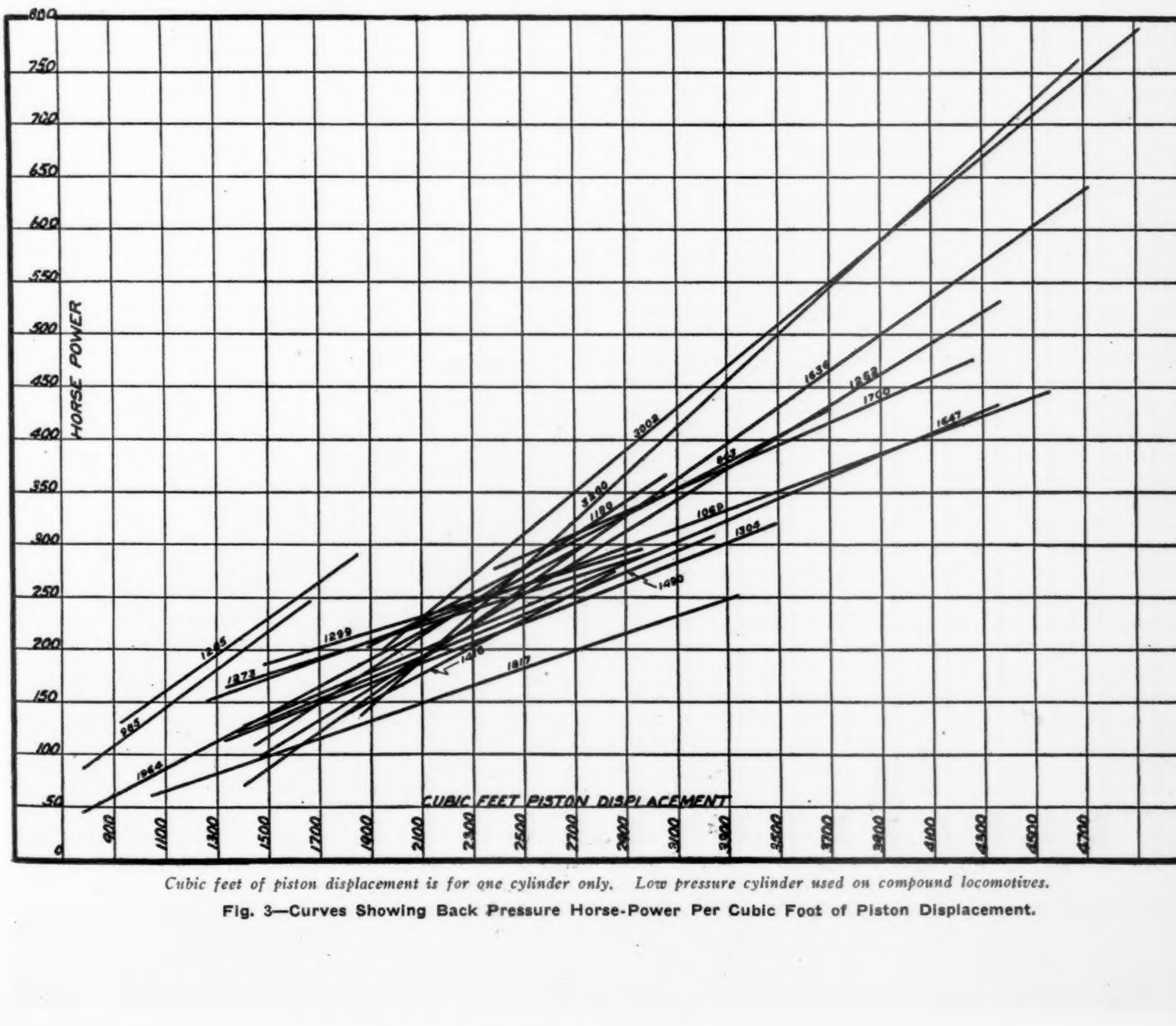


Fig. 4—Chart of Performance of Mikado Locomotive.

Assuming an exhaust pressure of 4 lbs., the back pressure horse power is shown with a dotted line. The difference then,



Cubic feet of piston displacement is for one cylinder only. Low pressure cylinder used on compound locomotives.

Fig. 3—Curves Showing Back Pressure Horse-Power Per Cubic Foot of Piston Displacement.

between the dotted line and the full line curves, is the horse power to be gained, if the exhaust pressure could be reduced to 4 lbs. This reduction in back pressure would increase the mean effective pressure an equal amount. This increase is shown by a dotted line curve.

Since we have supposed that the mean effective pressure is increased, then the indicated horse power would increase to an amount equal to the gain in back pressure horse power. Then, assuming that the machine friction of the locomotive would not increase with the reduction of back pressure, we have with the drawbar horse power an increase equal to the increase in indicated horse power. A dotted line also shows these results.

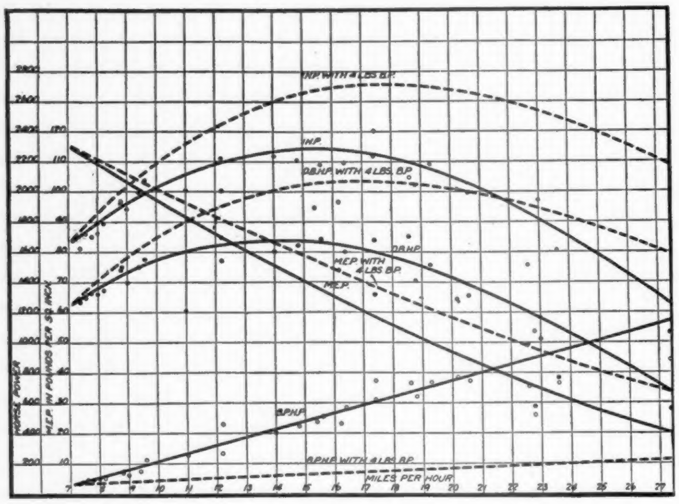


Fig. 5—Chart of Performance of Mallet Locomotive.

This locomotive, which is a coal burner, shows very favorable conditions of operation so that the actual gain is relatively low. The maximum speed shown is 26 miles per hour. The back pressure horse power at this speed is only 270, which is 32 per cent. of the drawbar horse power, and 26.5 per cent. of the indicated horse power. In comparison with conditions on other locomotives these figures are considerably below the average and indicate very favorable performance of this locomotive.

The chart presented in Fig. 5 has been prepared in similar manner to the preceding one and shows the performance of a locomotive of the Mallet type. This is an oil burner in heavy mountain service. A study of this chart will very readily show that the increased tractive horse power, due to the decrease in back pressure is very great. In this case the back pressure horse power and the drawbar horse power curves cross each other at a speed of 24.5 miles per hour, the power for drafting at this speed being equal to the effective work obtained at the drawbar. The maximum drawbar horse power is reached at a speed of 14 miles per hour, the back pressure horse power at this speed being 400, and the drawbar power 1,680.

If we assume a back pressure of 4 lbs. at a speed of 14 miles per hour, the drawbar horse power would be 1,960, and the back pressure horse power only 100, or the back pressure would then be 5.0 per cent. of the drawbar horse power instead of 24.0 per cent. The indicated and drawbar horse power decreases very rapidly at speeds above 14 miles per hour, and at a speed of 28 miles per hour the back pressure horse power and indicated horse power curves would come together at 1,200 and the drawbar horse power would be about 600, or 50 per cent. less than the back pressure horse power.

It can very readily be seen that the reason for the Mallet locomotive being a low speed engine is not due to machine friction, as has been frequently claimed, but to the amount of back pressure which is required to produce a draft. If the assumptions made were correct, with a back pressure of only 4 lbs. at 28 miles per hour, the indicated horse power would be 2,100, the drawbar horse power 1,500, and the back pressure horse power slightly above 200, which would mean that either greater speed could be obtained or, if this were not required, there would be a greater saving in fuel consumption.

The chart in Fig. 6, has been prepared from data secured in tests of a Pacific type coal-burning balanced compound passenger locomotive with cylinders 17½ in. x 29 in. x 28 in., and shows performance over heavy mountain grades with a train of 11 cars, or 644 tons. The back pressure on this engine was exceptionally high. At speeds ranging from 16 to 45 miles per hour, the back pressure horse power was 175 and 1,000 respectively. At a speed of 20 miles per hour the back pressure horse power was 220, the drawbar horse power 1,080, and the indicated horse power 1,400, or the back pressure horse power was 20.5 per cent. of the drawbar horse power and 15.9 per cent. of the indicated horse power. This locomotive attained maximum indicated horse power at a speed of 34 miles per hour. At this speed the back pressure horse power was 650, the drawbar horse power 1,200 and the indicated horse power 1,580, so that the back pressure horse power was about 55 per cent. of the drawbar horse power and about 41 per cent. of the indicated horse power.

It will be seen from a study of these charts that the back pressure horse power and drawbar horse power curves cross at a speed of 45 miles per hour and at a horse power of about 1,000. Assuming an average of 4 lbs. back pressure, the back pressure horse power curve has been plotted as a dotted line. The increased mean effective pressure, drawbar horse power and indicated horse power resulting from the reduction in back pressure are also shown by dotted lines. The increase in mean effective pressure, due to decrease in back pressure, is 10 lbs. at 20 miles per hour and 23 lbs. at 45 miles per hour. At the

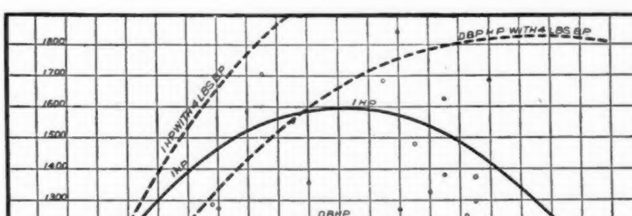


Fig. 6—Chart of Performance of Pacific Type Locomotive.

maximum indicated horse power, the possible increase in indicated horse power and drawbar horse power would be about 800.

This locomotive is of very recent build and its design is consistent with most modern practice for mountain passenger service. While it is giving satisfactory service, the great savings to be made in fuel consumption or the possible increase in speed by reduction in back pressure are readily apparent. With so high a back pressure it would be impossible for this engine to be efficient at any high rate of speed; in fact, it would be

impossible for the engine to maintain a high rate of speed with any considerable weight of train. At the speed of 45 miles per hour, where it should show its highest efficiency, it must give up an equal amount of power, to produce the required draft, as is delivered at the drawbar.

The calculation of the theoretical horse power required to draw the gases through the flues and front end of a locomotive is comparatively simple. The method employed in arriving at the data herein presented was as follows:

$$H.\,P. = \frac{PAV}{33{,}000}.$$

P = Pressure per unit of area against which the gases were pulled.
A = Total area of the tubes.
V = Average velocity of the gases in feet per minute, calculated as follows:

$$V = \frac{CB}{60A}\,F.$$

C = Cubic feet of air necessary per pound of fuel.
B = Pounds of fuel burned per hour.
A = Area of flues in square feet.
F = Factor for increase in volume of gases due to increase of temperature from 60 deg. F. to 700 deg. F.; assuming conditions from 60 deg. F. to 700 deg. F., this value is 2.2.

In obtaining the values of C, calculation was based upon the analysis of the fuel and flue gases as obtained upon tests of both coal and oil burning locomotives.

The weight of air per pound of fuel burned was calculated as follows:

$$A = 3.032\,\frac{N}{CO_2 \text{ plus } CO}\,C.$$

A = Weight of air supplied per pound of fuel.
N, CO, CO_2 = Percentage by volume of nitrogen, carbon monoxide, and carbon dioxide in the flue gases.
C = Proportional part by weight of carbon in the fuel.

Substituting actual figures in the above formulae, after reducing to unit of volume, gives a value of 185 cu. ft. of air per pound of coal burned.

Calculation by the same method for oil burners gives a value, in round numbers, of 200 cu. ft. of air per pound of fuel burned.

The following specific example will show the method:

ENGINE 923—COAL BURNER.

Run: La Junta to Trinidad.
Average fuel per hour = 4,415 lbs.
Draft in front end = 5.8 in. water.
Draft in front of tube sheet = 4.4 in. water.
Areas of flues = 1,265 sq. in., or 8.78 sq. ft.

$$V = \frac{185 \times 4{,}415}{60 \times 8.78} = 1{,}552 \times 2.2 = 3{,}415 \text{ ft. per minute.}$$

The power required to draw the gases through the flues alone will be

$$H.\,P. = \frac{(4.4 \times 0.0361) \times 1{,}265 \times 3{,}415}{33{,}000} = 20.8.$$

The horse power required to draw the gases through the flues under the diaphragm and through the netting equals 27.43.

The actual horse power utilized producing a draft in any given class of locomotive is taken as the horse power due to the back pressure in the cylinders. This back pressure horse power is not entirely chargeable to the production of draft because of the impossibility of operating non-condensing engines without at least 3 or 4 lbs. of back pressure. A greater part of the power thus expended, however, is used in producing draft alone.

The relation of horse power required for producing draft to the theoretical horse power required to draw gases through the flues and front end is shown in Table 5.

The above table is calculated from actual data secured in road tests of representative locomotives covering both freight and passenger, simple and compound, and coal and oil-burning engines. The figures given under the heading, "Calculated horse power required to draw the exhaust gases through the boiler," were obtained by the above method. The horse power of the steam jet for the various speeds in miles per hour was obtained from representative engines in actual service. The difference in these two values gives the excess in power directly chargeable to the exhaust jet. In the last column the values for this excess power consumed are given in percentages of actual work done.

It will be seen that the efficiency of the steam jet, as a means of producing draft in a locomotive boiler, is extremely low from a power standpoint. The efficiency, based upon a mechanical standpoint, i. e., the simplicity and reliability of this form of apparatus, is not included in this statement. It will be seen from a study of the above figures that the loss in horse power, due to the throttling of the engine exhaust, is somewhat startling, amounting in many cases to several hundred horse power.

TABLE 5.—RELATION BETWEEN POWER NECESSARY TO DRAW GASES THROUGH FLUES AND POWER EXPENDED IN LOCOMOTIVES AS DRAFTED.

Engine Number.	Calculated H. P. required to draw exhaust gases through boiler.	Back pressure at M. P. H.	H. P.	Excess power in jet H. P.	Per cent. of Required.
923 Coal burner	28	10	160	132	471
		15	275	247	882
		20	390	362	1,294
		25	500	572	2,041
917 Oil burner	25	10	150	125	500
		15	300	275	1,100
		20	450	425	1,700
		25	600	575	2,300
1700 Oil burner	65	10	290	225	346
		15	385	320	493
		20	480	415	639
		25	575	510	784
1301 Oil burner	25	20	300	275	1,100
		30	500	475	1,900
		35	600	575	2,300

If other means could be provided to draw the necessary volume of gases through the boiler for the same rate of combustion possible with a steam jet, at an expenditure of power somewhere near the calculated power required to draw the gases through the boiler, a tremendous saving in power would be accomplished. The power thus saved could be utilized in useful work, either as increase in speed or as a direct saving in fuel consumption.

The argument is often advanced that it is not economical to run locomotives at high speeds on account of the great back pressure and the loss in efficiency. This is a very pertinent argument in view of the facts. In service it is shown conclusively that the maximum power is obtained at speeds less than those desired for present time schedules. With increase in speed there is a proportional loss in horse power due to back pressure. The result is that at some speed a locomotive will have its highest efficiency and that speed is generally lower than the speed at which the locomotive is required to do maximum duty.

Discussion.—As a verbal appendix to his paper, Mr. MacFarland explained an apparatus with which he is now experimenting for mechanically furnishing draft on locomotives. This requires the use in the front end, of a fan operated by steam engine or turbine. This arrangement had been successful in burning the maximum amount of coal required on some heavy locomotives and it had also been used successfully on an oil burner. He found that about 27 horsepower was required to operate the fan for maximum coal consumption on non-articulated locomotives. It was estimated that 50 horsepower would be required on Mallets. In pointing out the importance of reducing the back pressure horsepower, Mr. MacFarland stated that it is not at all uncommon to have a locomotive which could pull nine cars successfully, but in case ten cars were used on the train, a second locomotive was necessary and both would then operate inefficiently.

W. E. Symons strongly endorsed Mr. MacFarland's paper, but stated that in his opinion other features should also be included. Some of these were of equal or greater influence on the final economy of the locomotive. In connection with back pressure caused by restricted steam passages or inefficient valve gears, no change in the front end arrangement could correct the difficulty. Frequently the nozzle is reduced on account of conditions which

are present only near the end of the trip, or a very small proportion of the time that the locomotive is in operation. In studying the subject some years ago on the Santa Fe he designed and applied a variable exhaust nozzle. It gave splendid results when it was in operation but was so frequently out of order that it was eventually discarded. He mentioned also a design of variable nozzle which was interconnected with the reversing gear, but did not state what the final results had been with its use. In 1899 some tests on a southern railway had shown decided economies from the use of a variable nozzle. Mr. Symons remarked that frequently, in their efforts to save five or ten cents, motive power officers were stumbling over ten-dollar bills and that the whole subject of steam economy was deserving of considerably more study than it is being generally given. The proper design of a variable exhaust nozzle at a very minor outlay might give as great an increase in efficiency as a superheater. He suggested that, in the future, papers like the one presented by Mr. MacFarland should include more details. In this case, for instance, he would like to know the type of boiler in each test. Tests had shown that an ordinary boiler on a Mallet required 7 lbs. back pressure to properly draft it while a boiler which included a feed water heater on a similar size locomotive required 11 lbs. back pressure.

F. O. Bunnell (Rock Island) asked for information in connection with the front end arrangement of an oil burner as compared with coal-burning locomotives, stating that the nozzle was frequently smaller on the oil burner. Some tests he had made showed the temperature at the stack to be 200 deg. higher with oil than with coal fuel.

Robert Quayle (Chicago & North Western) was not in favor of the variable exhaust nozzle because of the difficulty in getting the enginemen to properly use it, and also on account of the frequency with which it got out of order. He regretted that no information was given in the paper as to the openings in the ashpans which might vary considerably on different locomotives and be partially responsible for the back pressure shown.

R. Emerson pointed out the spasmodic method of locomotive improvement in this country, and, in contrast, stated that in England it took three years to build a new class of locomotive. One year was devoted to making the design, the second to the tests of two sample locomotives, and the third to the building of the order which would be duplicates of the test locomotives as finally decided upon. He believed independent valve gears are a necessity on the four-cylinder balanced compound locomotives.

Mr. MacFarland, in closing his paper, stated that the temperature in the front end of oil burners varied directly with the amount of soot on the flues. He had seen instances where the temperature in the front end was reduced 250 deg. in two minutes by sanding the flues. Each reduction of 25 deg. gives one per cent. increase in boiler efficiency. He objected to the use of variable exhaust nozzles because of the difficulty in getting the engineers to properly operate them.

INSPECTION OF FUEL FROM THE STANDPOINT OF THE PRODUCER AND THE CONSUMER.

J. E. Hitt presented the standpoint of the producer and strongly advised more rigid and careful inspection of railway fuel at the mines. He said it was hard to take seriously complaints received at long intervals from railways, which did not maintain inspectors, as they generally seemed so disinterested in the subject. He suggested that a coal miner be selected from each mine producing railway coal to act as an inspector. This man could represent all the railway companies purchasing from that mine.

The standpoint of the consumer was presented by Glen Warner, fuel inspector, C. H. & D. He also recommended more careful inspection and outlined the formation of an efficient fuel department so far as the inspector's duties were concerned. He stated that after acquainting himself with the traffic movement between the mines and the final destination, the inspector's place should be on the road and that only an occasional visit to the mines was necessary. The greatest difficulty with poor coal comes through carelessness but he did not advise the use of a penalty system. Frequently the inspector should supervise the weighing of all cars and check up the way-bills.

Discussion.—More systematic, thorough and intelligent inspection was generally favored by both the coal operators and railways. While some of the recommendations of the authors did not meet with general approval, an improvement in the methods of inspection appeared to be strongly favored.

C. Scovell (Central Coal & Coke Co.) strongly favored the presence of the railway inspectors, stating that they were the operators' greatest protection. When there is a man present who has a knowledge of coal, the coal companies are relieved of many troubles in connection with straightening out complaints based on the reports of enginehouse foremen, coal chute men, etc., who generally are not very expert in judging coal. He admitted that the miners frequently get careless and the presence of an inspector tends to keep them watchful. As a further argument, he related instances where coal had been sent to a road which finally cost it more per car than the salary of an inspector for six months.

A new system of inspection that is giving satisfaction was described by T. Fawcett (C. P. R.). All coal is purchased on a specification based largely on the ash content. This is varied for the different mines, and the price paid is adjusted on this basis. There are two men at each mine, a sampler and an inspector. The sampler collects a 100 lb. sample from the chute as the coal is running in the car and the inspector separates this in the usual way and tests for the ash content. Twenty tests per day can be easily made and the cars are never delayed if the coal comes up to specifications.

STANDARD COAL ANALYSIS.

J. S. Sheafe (Ill. Cent.), as chairman of the committee on this subject, read a report in which the methods recommended by the American Chemical Society were stated to be the most suitable. If the association did not wish to adopt any standard at this time, the committee urged that the method actually used in any case, be specified. Some form of Baumé calorimeter was recommended. The committee was continued and asked to keep in touch with the other societies interested, making all efforts to secure a universal standard analysis.

OTHER BUSINESS.

It was voted that standing committees be appointed for the consideration of subjects of particular interest and importance to the members. It was suggested that these be fairly large and that the membership be changed in part at each meeting.

Standing committees on the following subjects were approved: Firing practice; fuel stations; distribution of information; constitution and by-laws.

Dr. W. F. M. Goss, dean and director of the College of Engineering, University of Illinois, was unanimously elected an honorary member of the association.

The following officers were elected for the ensuing year: President, H. T. Bentley, assistant superintendent motive power, C. & N. W.; first vice-president, R. Collett, superintendent locomotive fuel service, St. L. & S. F.; second vice-president, D. B. Sebastian, fuel agent, C. R. I. & P. Executive committee, two years, D. C. Buell, J. G. Crawford and R. Hibbit; one year, R. Emerson, W. H. Averell, and W. C. Cox. Chicago was practically the unanimous choice as the location of the next convention.

Wireless Telegraph for Aeroplanes.—According to a press despatch from London, April 10, experiments made by the British army officers, in conjunction with the Marconi Wireless Telegraph Company, have resulted in sending messages both to and from an aeroplane flying in the air, at points several miles from the station on the ground.

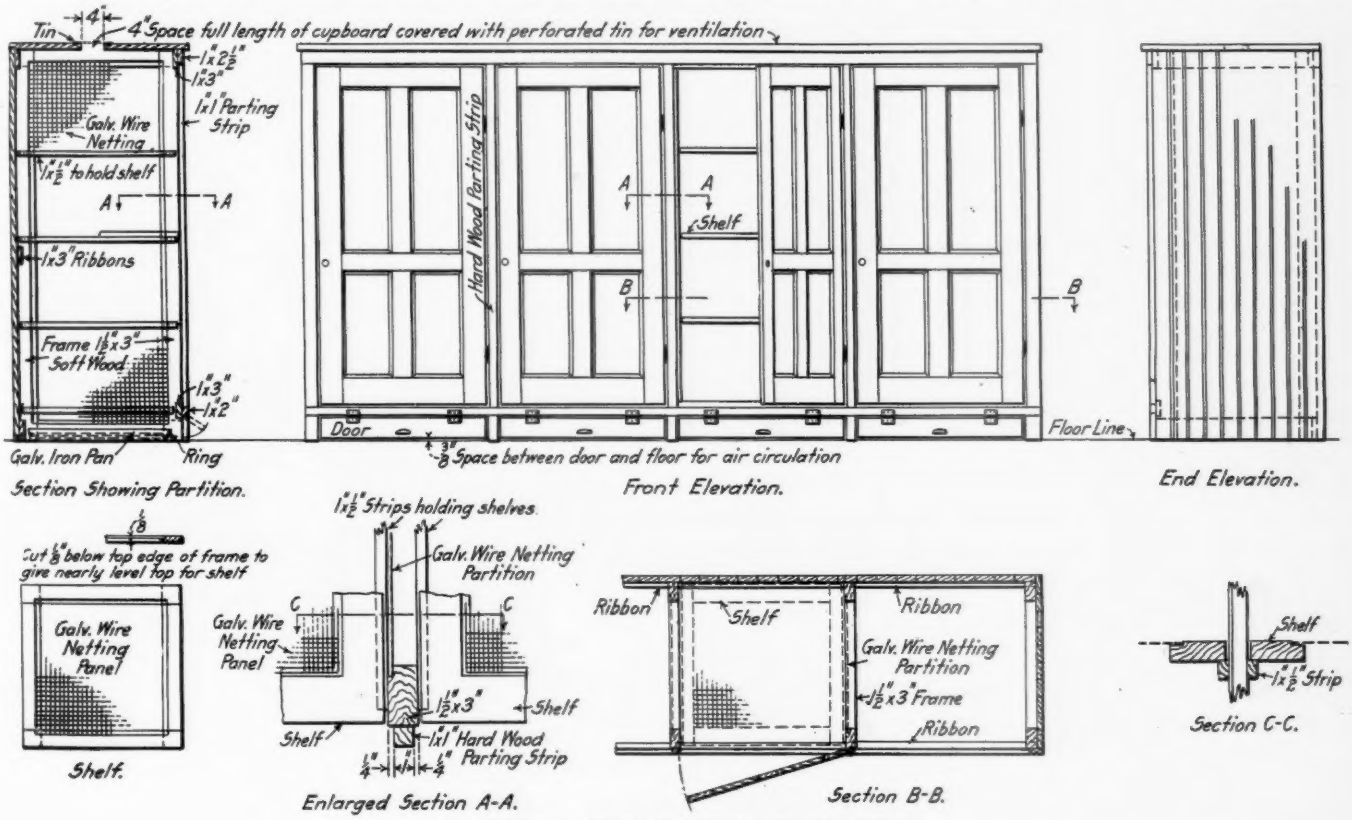
PAINT BRUSH STORAGE

BY H. M. BAXTER,*

Proper storage for brush stock is a problem always before the master painter, and it is none the less his problem when a storekeeper has general charge of the brushes. Where proper storage conditions are not provided, their lack is brought to mind most forcibly and disagreeably, through the falling apart of the brushes, due either to the extremes of heat, dryness or dampness. If stored in too damp quarters, they will suffer just as much as though kept too near a steam pipe or in exceedingly dry air. This is due partly to the peculiar formation of the bristle itself, such hair being more or less porous—a succession of tiny cells, each overlapping the other—which give the bristle its strength and elasticity. In very damp air, these cells absorb the moisture, making the bristle flobby and unfit for use in oils, turpentine or spirits. This characteristic also renders it susceptible of a certain deception in weight, for a difference of 10 per cent. is not impossible between very dry stock and that which has been stored in damp places. The specifications for the weight should take this into consideration.

Further, the method of putting together the round and oval paint and varnish brushes is such as to cause serious trouble if they are kept in too dry air. They are made by driving a wedge-shaped handle through the center of the bristles, in such a manner as to bind them tightly against the ferrule, or encircling band of metal. While cement is used in the bound end of the bristle, the real holding power is in the tightly driven, wedge-shaped wooden handle, and any contraction of this handle, whether caused by dryness or other reasons, will eventually allow the brush to fall apart. In cases where the handles of such brushes have become loose, the remedy is simple and effective. Part the bristle in the center and pour half a teaspoonful of water (less if a small brush and a little more if very large) directly on the end of the wooden handle. Then allow the brush to season, with the bristle end up, for an hour or so; replace the brush in its proper wrapping and allow to lay over night, when it will be sound as ever and ready for use.

The accompanying illustration shows a "humidor" or a system of storing brushes, which with slight variations has been installed and thoroughly tested by several large railway systems and found to be satisfactory and convenient in all details necessary for the preservation of brushes during storage. No general dimensions are given, and all drawings, notes and data have been carefully worked out to expedite construction for any given size. The number of shelves, sizes of compartments and over-all measurements must necessarily be based on available space, as well as quantity of stock to be cared for. Owing to its natural moisture-withstanding qualities, cyprus is undoubtedly the best wood to use in building a humidor, with sycamore and poplar as substitutes, though any sound wood will answer the purpose. From the viewpoint of economy alone, as well as promptness in obtaining material and effecting any later additions or repairs, it is best to use only standard sizes and supplies. All shelves and all the inside partitions (those between compartments) are cut away in the center and grooved (see the sections *AA*, *BB*, *CC* and the shelf in the drawing) so as to allow for the insertion of heavy wire netting. A 4-in. ventilating space runs along the top and is covered with perforated tin.



A Humidor or Closet for Storing Paint Brushes.

Under each section is a space for a galvanized iron pan, which is to be kept filled with water, and should be equipped with a ring for use when removing the pans to change the water. These spaces are fronted with loosely fitted hanging doors, with a ⅜-in. opening around the sides and bottom. With these air-supplying provisions, the ventilation is practically perfect, allowing a free circulation of air and preventing any accumulation of moisture. The doors may be paneled as shown in the drawings, or made to conform with the rest of the building, as desired, and may be provided with locks, if necessary, or simply fitted with springs to keep the doors always closed. A convenient addition for the storekeeper is a compartment built at one end having a solid top, shelves and partitions (no iron netting or perforated tin) and containing no water pan, so as

*Kip Brush Company, New York.

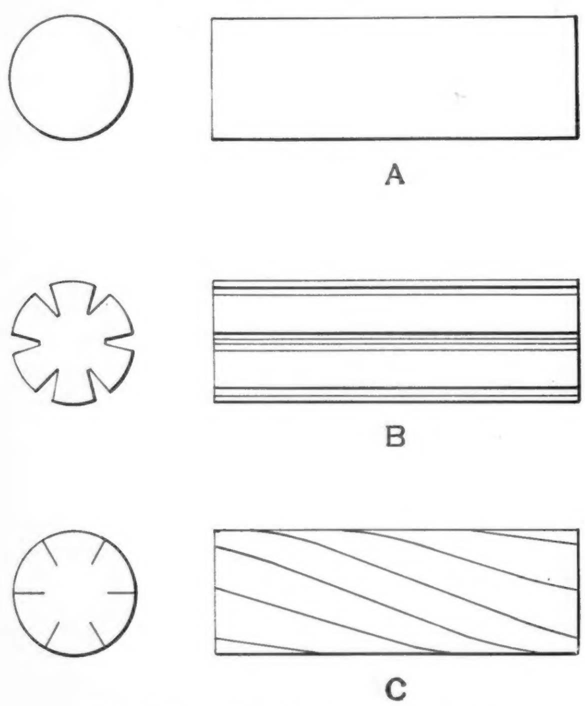
to permit the storage of wire brushes, which require absolute dryness, on account of rust. The supply of chamois skins, putty and scraping knives, sponges, feather dusters and the many other articles that always go with such stock, can also be stored in this compartment.

To aid the wood in resisting decay, and also to help the ventilation, the entire inside of the complete humidor should be giving a priming coat of ¾ linseed oil and ¼ dryer, followed, when thoroughly dry, by one coat of varnish. The exterior, of course, may be painted or finished in any way desired.

Moths eat only the extreme end of the bristle, known as the "flog end," as that is the softest portion, and as it is also the only part which spreads and smooths the paint and varnish, its removal naturally ruins the brush. To keep out the moths, it is wise to sprinkle a pinch of moth flake, or insert a strip of tar paper, in each box of brushes, before placing them in storage. However, moth flake should never be placed in boxes containing brushes which are set in pitch, as the action of the flake tends to soften the pitch and thereby allow the "knots" of bristle to fall out. Many floor brushes and counter dusters which have fallen apart are damaged by having come in contact with moth flake. Any oily or greasy substance produces the same effect on pitch, and in all cases where a brush is to be used in or around oil or grease, it should be made wire drawn, instead of set in pitch.

SPIRAL STAYBOLT

The staybolt shown in the accompanying illustration is designed to withstand the ever changing stresses it may receive in the firebox of a locomotive boiler with a reduced possibility of fracture. In such service staybolts are subject to considerable repeated stresses, which materially affect the strength of the outside fibers of the bolts. With the staybolt in question this deteriorating



Spiral Staybolt for Locomotive Boilers.

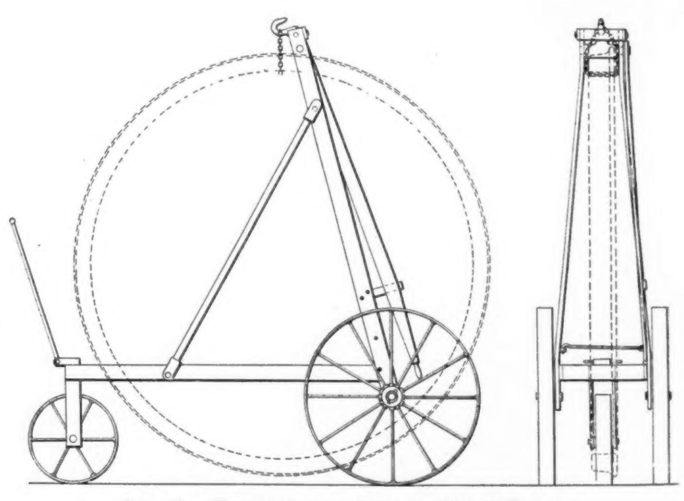
effect is considerably reduced on account of the slots which greatly increase the flexibility of the bolt.

The process of manufacture is as follows: The bar is heated and drawn through a specially constructed die in which are inserted six rotary splitting cutters, so arranged as not to actually cut the metal but merely displace the fibres as the bar is drawn through the die. When the bar leaves the die its cross section is as shown at *B*; while it is still hot, it is passed through a set of closing rolls which bring it back to its original shape, completely closing the longitudinal incisions made by the splitting dies and finishing the bar as shown at *C*. The rod is twisted one revolution in 12 in. As the whole process is conducted at a heat considerably below the welding temperature, it will be seen that, whereas the bar has the appearance of an ordinary bar of staybolt iron—the faint lines of the incisions will be barely perceptible—yet as a matter of fact, in so far as stress considerations are concerned, it is composed of seven distinct members, similar to a wire rope, each having its own separate neutral axis. This operation does not detract from its ability to resist longitudinal elongation and experiments have shown in the majority of cases that the direct tensile resistance of the material is actually improved by this treatment. The splitting dies referred to do not extend the incisions beyond one-third the diameter of the bar.

Tests have shown that a piece of staybolt iron in its original form broke after 15,560 revolutions on a repeated stress testing machine, while the same material constructed as described failed at 114,120 revolutions. Both test pieces were 8 in. long and had a load of 4,000 lbs. which gave 7,018 lbs. per sq. in. fibre stress at the root of the thread. The eccentricity of vibration was 3/16 in. and the machine was run at 84 r. p. m. This staybolt is made by the Patterson-Allen Engineering Company, New York.

TIRE TRANSFER CART

At the Clinton, Iowa, shops of the Chicago & North Western a three-wheel car has been designed for transferring driving-wheel tires with much greater safety and convenience than the customary method of placing them on a truck or rolling them by hand, especially in cases where the tires are stored in an upright position. The construction of the cart is clearly shown in


Cart for Transporting Driving Wheel Tires.

the illustration. The brace between the two large wheels is in the shape of a hook, which can be released when the tires are being rolled into place. The long handle hinged at the top has a short lever arm extending from its upper end with a hook from which the tire is suspended by a suitable length of chain. The handle is raised up and the chain looped around the tire with as little looseness as possible, so that when the handle is drawn down and latched the tire is lifted and supported clear of the ground. This cart has also been found convenient for handling front end rings. It was designed by H. Harrison, machinist at the Clinton shops.

Canadian Coal.—It has been estimated that there are about 30,000 square miles of coal lands in the Dominion of Canada which contain about 172,000,000,000 tons of coal.

Railway Storekeepers' Association

Ninth Annual Meeting. Abstracts of Reports and Discussions of Special Interest to the Mechanical Department.

The ninth annual convention of the Railway Storekeepers' Association was held at the Hotel Statler, Buffalo, N. Y., May 20-22. After an address of welcome by the mayor of Buffalo and remarks by J. A. Waterman, the past president, and by E. Chamberlain, of the New York Central Lines; W. F. Jones, general storekeeper of the New York Central & Hudson River, the president of the association, made an address. Special mention was made of the work of the committees, and particularly of the tinware committee, which had been in conference with similar committees of the Master Mechanics' and Master Car Builders' Associations for the purpose of standardizing tinware. It is believed that the action of this committee, if accepted, will result in the adoption of standards that will be of great benefit both to the railways and to the manufacturers. In fact, some roads are waiting for this report before ordering large amounts of tinware.

The membership of the association has been increased, the total number, according to the secretary's report, being 625. There were 210 members present at the convention.

RECLAIMING SCRAP MATERIAL.

The subject of railway salvage, or reclaiming scrap and the question of apprentices in the store department, were considered by the committee on recommended practices; H. C. Pearce, Southern Pacific, chairman. The latter subject was considered sufficiently covered in the paper presented by J. A. Waterman, of the Chicago, Burlington & Quincy, at the fifth annual convention. The former subject, however, was presented in detail and the substance of the report is as follows:

A separate salvage department was advocated, which should come under the direct control of the supply department. This new department should gather all obsolete and scrap material and arrange for its reclaiming or selling. It should be run according to a definite and well-planned system, so as to prevent any unnecessary handling. It was estimated that 10 per cent. of the total cost of the material could be saved. Three inspections should be made of the material before it was scrapped; the first by the workmen overhauling the equipment for repairs; the second by sufficiently trained men at the scrap piles, and the third as it is being loaded on the cars for shipment. It was claimed that considerable money is lost in rails and ties which could oftentimes be reclaimed by shortening the rails and by using the ties for secondary track and fence posts.

In addition to the report of the committee, E. J. McVeigh, Grand Trunk, who was also a member of the committee, read a paper on the subject, of which an abstract follows:

Today, and in the past, we have spent money each year on our scrap, and no matter how much, or how little, we spent, we considered it well spent. That is, it brought us a good return. What we want to consider is, should not we spend a little more and secure a much larger proportionate return.

We lose and waste through handling of oil in wooden barrels; by leaving perfectly good fittings on pipe sent to the scrap pile; loss of coal picks, oil cup covers, and many other things dropped from engines and cars, picked up by section men, and held by them instead of being sent in. The manufacturing in our own shops of many items of material that could be bought cheaper in the trade. The loss of air and steam heat hose and couplings through ignorance and carelessness. Putting into the scrap pile second hand material that might be used in place of new. The holding, by departments, of surplus material that should be sent in for redistribution. The putting into the scrap pile of new material because we have no proper place for it. Stealing of brass scrap (there is generally more of this going on than we think). Throwing away barrel hoops, and very light steel metal. The abuse of oil cans, and other tinware by those using them. Keeping on hand material that has been purchased for a specific purpose, but owing to change of plans is not used for that purpose. Waste of stationery by clerks, and multiplicity of forms, letter heads, printed envelopes, etc. The purchase of cheap (first cost) material and use made of it. Improper use of fog signals and fuses by trainmen and others. Improper care of classification lamps, and train markers. The carrying in vans of excessive quantities of material. Destruction of wire cable owing to improper care and lubrication, and the attempt to use cables in places they are not designed for. Waste of cleaning soap, owing to its being too green, not cured properly.

These are a few of the items that occur to me off hand, and I have no doubt many more will come up in the minds of all good live storekeepers.

Fifty per cent. of all our loss and waste is the result of lack of education; the balance is due to pure "cussedness." This lack of education is not confined to any class or department. That we have, in many cases, insufficient storage facilities is due to lack of education on the part of our higher officers. They have not been educated to see the necessity for them. The abuse of oil cans and tinware, is due to pure cussedness on the part of those using them. The holding of valuable material by employees is due to lack of education or proper instructions. The loss of air and steam heat hose and couplings is a combination of the two evils mentioned.

You may note the item "new material put in the scrap pile because we have no other place to put it." By this is meant the short ends of iron bars, pieces of pipe, etc., that accumulate around our iron and pipe racks, and look so untidy, finally being put into the scrap some day when we have a good clean-up, ahead of the visit of the big fellows. There are few shop foremen, or storekeepers, who have not been bothered with this. Then there is the good second hand material that often finds its way into the scrap, just because there is no regular place for it, and it makes the place so untidy.

If we will examine our scrap piles at different shops, and observe what is put into them, and the men who put it there, we will realize how difficult, how impossible, it would be to properly control this in detail. To do this would cost us more than the material is worth, and we could not very well have proper facilities for this rescue at a dozen different places, so if we cannot control it at one end, or in the middle, we must make the effort at the other end. If this education and rescue work is to be done we must have some one to do it, and the facilities for doing it. And my idea is that at some central point, we should have this some one, and these facilities. These would consist of first, a man thoroughly familiar with railway material, and with knowledge of his road. He should have plenty of room, with a platform and sorting bins just a little too large for his work. He should have the tools necessary, and a few pieces of machinery, such as shears, bolt machines, pipe machines, rail saws, rail benders, etc., and in addition a storage building sufficiently large to hold material as rescued, or manufactured.

To such a place would be sent all of the scrap, second hand and surplus material on the system. It would be the business of the man in charge, with the assistance of other men of the supply department, to see that such material was sent there

promptly in carload lots; and here the real salvage work would be done. This would consist of the rescue from the scrap of all bolts that are worth cutting and rethreading. Also all short pieces of round iron that can be made into bolts. The cutting up of larger iron for the same purpose. Re-tapping of nuts that may be used again, cutting off the good ends of damaged pipe, and making it into nipples. The saving of rails with damaged ends. The cutting off of coupler pockets. The careful testing and selecting of coupler knuckles. Cutting up of scrap frogs and old tanks and boilers when considered advisable. The straightening and trimming of bar iron. Removal of good fittings from scrap pipe. The rescue from the scrap of all material that may be used without change, and many more things that will be noticed as the work proceeds.

Then there would be the final sorting of the actual scrap into the classes that would bring the best price in the market. This would be no small man's job, as the man doing it must not only know railway material from A to Z, but must study markets and keep in touch with their requirements, and while not doing the actual selling he must arrange his material to be sold to the best advantage. Finally this work should be done under the direction of the supply department. There is one item that needs special attention, and that is the air and steam heat hose and couplings. There is a good opportunity to effect a saving of from $10,000 to $30,000 in this item. Just how it can be done I know, because I have done it, and would be glad to tell anyone who has not done it.

As I have intimated this salvage question has been left too much in the hands of the different departments, and many individuals. What is everybody's business is nobody's business. Under the plan proposed this would be changed. The salvage man would hunt up the salvage, and see that it came in.

Discussion.—The discussion of this subject brought out the various methods and systems used in the gathering and reclaiming of scrap. H. E. Rouse, Chicago Great Western, spoke on the advantage of using the scrap classification as drawn up by this association, stating that his road received on an average $1.38 more per ton by using this classification than by selling the scrap unclassified and as general scrap. The increased cost of operating this system was more than paid for by the additional material reclaimed.

The question of local or general scrap docks was discussed quite fully and the consensus of opinion seemed to be that as much reclaiming as possible should be done before the scrap is sent to the general scrap bins, and at these bins the scrap should be classified and carefully inspected for any usable material. Some roads, however, send all their general scrap to the general scrap bins and have it sorted and reclaimed there, but it was contended that the cost of hauling this usable material back and forth over the lines would be more than the money saved by the use of second hand material.

J. P. Murphy, Lake Shore, suggested that a definite set of plans be drawn up for handling the scrap for classification and reclamation, and suggested that all material should be painted and made to look as nearly as possible like new, for it had been his experience that such material would find much better usage at the hands of the shop men. Friendly competitions should also be carried on between different departments, to see which returns the least usable material.

C. A. Roth, of the Chicago, Burlington & Quincy, described the method used on that road. The mechanical department cooperates with the supply department and general reclaiming of the scrap is done at the shops and the remainder is taken to the scrap docks at Havelock, Neb. At this point a regular plant is laid out in a systematic manner, magnets being used for loading and unloading the scrap.

W. R. Schoop, of the Buffalo, Rochester & Pittsburgh, stated that his road had installed reclaiming rolls with which large savings are expected to be made. The scrap docks on that road are arranged in the form of a circle, with the distributing bin in the center and classification bins radiating from that point.

In connection with this subject a query was sent in by one of the members asking whether the saving would justify using a $50 or $60 man for classifying a scrap pile of about 70 tons a month. It was decided that if the man was limited to this work alone the expense would not be justifiable, but it was questioned as to whether he could be kept busy enough on that job; if he was used on other work as well it would be worth while. However, a good man at the scrap pile is an absolute necessity, not only for the money he may save but for the moral effect he will have on the departments sending in scrap. For if these departments find that the scrap man is returning usable material they will be more careful about sending it in, especially, as is the case on some roads, where the general superintendent requires a report of the usable material returned to each department.

The committee on scrap classifications made a few changes in these classifications, which were found necessary on account of the increasing use of steel in railway work. However, no change was made in No. 1 wrought scrap, which is No. 66 on the storekeepers' classification and is defined as follows: "Clean wrought iron from railway equipment. Pieces measuring 4 in. long and over, exclusive of threads, may include rods and bolts ⅜ in. in diameter, except track bolts; also drawbar yokes, bridge irons in bars or rods, heavy iron chain, links and pins; all to be free from riveted material." In assigning scrap to this classification it is practically impossible to determine whether the material is steel or wrought iron, and as a result the combination will be almost half and half, steel and iron. This is severely objected to by many of the scrap purchasers, and no doubt this classification will have to be changed.

OIL AND WASTE.

Papers were presented on this subject by W. O. Taylor, Galena Signal Oil Company; C. H. Tallman, New York Central & Hudson River, and E. C. Totten, of the same road. An abstract of Mr. Taylor's paper follows:

Present-day train service requires a light of greater candle power, and more reliability than is possible with common kerosene and the manufacturers have met this demand with a compounded oil, water white in color, 180 deg. fire test, 48 to 49 gravity, and 20 deg. below zero cold test, that has a candle power that meets all the requirements in those states where the law had heretofore forced an oil light from the service. The reduction of the number of headlight cases, reflectors, and chimneys furnished, where this oil is used, has contributed to a lessened expense for handling material.

The signal oil extensively used in railway service for light and signals, and mainly used in hand lanterns, has a fire test of 300 deg. Fahr., or more, a gravity 34 to 35 deg. Baume, cold test about 16 deg. above zero, color clear and light and is practically free from acids and alkalis. On account of its important service it should receive the greatest care, and its fine illuminating properties be guarded from the contamination of mixing with other oils, and from water and alkalis. This oil should never be stored in galvanized iron tanks or shipped in galvanized iron cans—for the reason that the animal oil in the compound acts on the zinc, dissolves it, and causes the signal oil to become green and rancid, utterly ruining it for the purpose for which it was made. Steel and iron tanks and heavy tin cans are the best containers. Before tin cans are used for signal oil, care should be taken to wash them free from all foreign substances, and particularly any of the acids used in soldering.

This oil should not be exposed to the extremes of heat or cold, for these conditions tend to a separation of the elements of which it is composed, and seriously affect its illuminating quality.

There should not be kept in storage more than a 30 to 60 days'

supply, and the storage tanks for holding this oil should be cleaned every six months, and in no case should they go longer than one year between cleanings.

Absorbent towels have been furnished workmen on a road as a substitute for waste for general wiping purposes. An "emulsion machine," which is of the centrifugal type, for extracting and filtering the oil removed from these towels was installed, with the following results:

"Extracted from dirty towels. 615 gal., value 8c. per gal., with a 15-in. emulsion machine.

Total	$49.20
Total cost to filter	3.34
Showing clear profit of	$45.86

This oil was accumulated at this shop, from these dirty towels in about 65 days. This amount was shipped to the signal department, billing them 8c. per gal., and was used for lubricating switches."

Again quoting, "During the month of January, we washed 6,695 towels, at a cost of $26.50, and furnished the entire division with same daily, and I believe that there was no complaint that anyone was short of towels and could not perform the same amount of work as they could with the waste, thereby showing a saving, of about 4,000 lbs. of colored waste, which we furnished previous to this, to the different points for the same wiping purposes. Taking these figures into consideration, we consider that we saved 24,000 lbs. of the colored waste in six months, value $1,440, less the 6,695 towels at 4½ cents apiece, amounting to $311.28, showing a saving in six months of $1,138.72, or a monthly saving of $189.78. Subtracting from this the cost of washing towels, $26.20, leaves a net saving of $163.28 per month. We figure that the life of one of these towels, under fair usage, to be about five to six months.

Valve, engine, coach and car oils are compounded from selected mineral and animal stock that is best adapted for the service required, with petroleum as the basic ingredient. The distinguishing characteristics of a valve oil are a high fire test, a high cold test, and lower gravity.

To the engine, coach and car oils there is added oxide of lead, and in such proportions with the other ingredients of these oils, as to make them best adapted for the service indicated by their trade names. The process of manufacture so thoroughly mixes the lead with the oils, that unless exposed to long periods of absolute rest, it will be held in suspension. The leading characteristics of these oils, is their adaptation to the varying climatic conditions.

Again referring to the results obtained from the use of the emulsion machine, which extracts the oil by centrifugal force, the same force being utilized for filtering the oil, it was said:

"We also have filtered, through this machine, car oil which is taken from dirty waste received chiefly from demolished cars.

686 gallons, value 19c. per gallon, total		$130.34
Cost of filtering, one man at $1.76	5.54	
Cost of lubricating the machine	.94	
Total	6.48	
Showing a saving of		$123.86

"This covers about a 30 days' working of one machine, whenever we found time to reclaim this oil."

The information furnished has been confirmed by the writer's experience, and the centrifugal machine which extracts the oil from the waste, can be then used as a filter for the oil, and after the separation of the dirt and portions of waste unfit for further service, the oil can be used for resaturation of the good waste. Reclaimation of journal box packing has been adopted by many roads with very satisfactory results.

Less expensive than the centrifugal machine, and very efficient, is the process of submerging or washing the waste in hot oil; in connection with this process suitable filtering or settling tanks should be installed and the dirty oil can be thoroughly cleansed and restored to service.

As illustrative of the possibilities of this system, here submitted, are figures covering a period of one year, and the first complete year after the system had been thoroughly installed.

All packing used on the system is prepared at three central points. Car oil is received in tank cars from the manufacturer, unloaded into the storage tanks in the basement of the oil station by gravity, thence raised by air pressure to a distributing tank located above the saturating tanks which are on the ground floor.

These tanks are connected in series of three or more, numbered, and are in communication with each other by means of a circulating pipe, and also carrier ways upon which rests a cylinder press operated by air pressure. The capacity of each of these tanks is 80 lbs of waste, and 90 gals. of oil.

After a saturation of 48 hours in tank number one, communication is made with any other tank in the series; to illustrate, tank number ten, and the movable press is rolled over tank number one, and 50 gals. of oil is pressed from this tank to tank number ten, leaving in tank number one, 80 lbs. of waste with 40 gals. of oil, or four pints to the pound, a total weight of 380 lbs. of prepared packing, or two barrels. This is shipped in tight barrels with removable heads, to the points where used, there dumped into a tank with screen and faucet, and as the oil flows by gravity to the well below the screen, it is drawn off and poured over the packing.

All journal box packing when removed from the boxes in shops, repair tracks, or along the road is supposed to be sent to the reclaiming plant, which is at the same station where new material is prepared. This old material is sorted over, heavy portions of dirt, coal, etc., shook out, metal picked out, and the short strands shaken out. It is then passed through the hot oil tank, where the action of the heat expands the oil, separating the strands of the waste. After 10 to 15 minutes in the hot oil tank it is in condition to be removed by forks and placed on the drainage screen which is independent of the hot oil tank and is not exposed to the heat, to guard against too rapid drainage. When drained sufficiently to approximate the proportions of 4 pints of oil to one of waste, this is mixed with new material in the proportion of 50 per cent. of each, and sent out to receive the same attention and use as new packing. The only charge for material is the new oil placed in the boiling tank.

The results for one year were interesting, and as compared with the previous year before this system was installed, very satisfactory.

Old packing, dirt, etc., removed from freight cars	262,548 lbs.
Reclaimed and returned to service	171,227 lbs.
Babbitt metal recovered	4,223 lbs.
Oil used in process	499 gals.
Labor cost	$759.72
Cost per pound to reclaim material	.0037 cents

As compared with the previous year, there was an increase of 3,392,430 miles, a decrease in total oil consumed of 3,783 gals., a decrease in waste used of 52 per cent., an increase in miles run per pint of oil from 424. to 474., a decrease in cost per 1,000 miles run from .0528 to .0475, and an increase in miles run per hot box from 49,666 to 50,805 miles.

The commercial term "waste" applies to a by-product of the manufacture of cotton and woolen textiles, and, without other designation, should only apply to straight products, which range in value from that of clear white, soft cotton, and long strand wool, to the poorer grades, coarser in texture, but retaining purity of stock. The blending of cotton and wool in the right proportions produces a "mixed waste," combining properties that gives it a value for journal box packing.

As distinctive characteristics of cotton waste, it excels in absorption and capillarity, and is best adapated for general wiping and cleaning purposes, and is used with a measure of success as journal box packing.

Wool waste excels in expansion or elasticity. The leading characterstic of the several "packings" is the claim for their

elasticity and resiliency. It has been the writer's experience that the superior service from a good grade of wool waste justifies its exclusive use for journal box packing.

There is an important possiblity in the reclaimation of waste that nas been used for general locomotive and car cleaning, by the simple process of boiling. With the exception of waste that has been used for wiping paint, varnish, or like sticky surfaces, a large percentage can be reclaimed for further use and repeated cleanings. As evidence of this, data from one road is sufficient. Ninety-five per cent. of the total amount sent to the reclaiming plant was returned to service at a cost of .0099c. per pound. This expense would have been lessened had the attendant been constantly kept busy on this process, and the output increased without additional labor cost.

Mr. Tallman said, in part:

In connection with this subject the proper handling of grease should be considered. The quality of grease can be easily found if one follows this simple procedure:

Take a small piece of grease and work it between the thumb and fingers until it is slightly warmed, and if the grease cleans off readily, leaving a smooth, shiny surface, the quality is all right. If, however, it works into a soft, sticky mass, and pulls out in strings between the thumb and fingers, it is safe to assume that the quality is doubtful and it should be so reported.

Grease for either rods or journals should be protected from the elements and from dirt or other foreign accumulations. For this reason, barrels should be kept covered and all possibilities prevented of anything foreign becoming mixed with the grease.

The effect of water is very disastrous to the grease, as it not only saponifies it, but carries away the free alkali and other lubricating qualities, leaving nothing but a soft, sticky mass.

The object of the perforated plate in the driving box cellar is to provide the means of forming the vacuum necessary to deliver the grease to the journal and at the same time retain the grease to the greatest extent possible and still give sufficient for proper lubrication. It is of the greatest importance then that the perforated plate be in proper contact with the journal, otherwise the running temperature of the journal will be increased. If the increased temperature is excessive, we find that hard, blackened condition of the grease which has remained after the free alkali evaporates and the remaining substances have been subjected to extreme temperatures.

We can assist in overcoming excessive use of greases by protecting them in our oil houses and we can also enforce further economies through reclaiming grease removed from cellars wnen engines are undergoing repairs. The easiest and most successful method for reclaiming this grease is as follows:

Put 100 lbs. of old journal compound in a large kettle and melt it. Then add to this 50 lbs. of water and stir. Then take 3 lbs. of caustic (sal) soda, dissolve, and stir in thoroughly. Allow this mixture to boil slowly, skimming off the dirt and foreign matter which may rise to the top. Continue the boiling until the water has evaporated, then slowly stir in 7 lbs. of valve oil. This will give a grease equally as good as new stock.

Finally, I would urge a systematized effort in the protection of new grease, the reclaiming of old, and exerting our influence among the users both in the shops and engine houses for careful attention in the application and care of the device which applies it. We should see to it that our houses are equipped with a machine for properly preparing the grease, both in cakes and candles, and that close record is kept of all distribution. The value of a pound of grease is considerable, and if we are lax in protecting it against uses other than for which it is intended, we are not doing our full duty.

Mr. Totten in his paper on the subject took up the question of journal boxes, and said in part:

While hot boxes are, of course, sometimes caused by mechanical defects, I believe that fewer result from this cause than is generally supposed. A journal nearly always begins to heat at the back end of the box, caused, no doubt, by the fact that at that point there is more weight, more dirt and less lubrication, and it has been noted that not enough attention is paid to truing up oil boxes and equalizers when cars are being overhauled. I would recommend, in this connection, instructions be issued to shop foremen that will insure as nearly as possible giving the equalizers a proper bearing.

I venture to say that 90 per cent. of all oil in journal boxes is wasted. Oil should never be poured into a box without first picking the waste and crowding it back against the wheel plate of the box twisted in the form of a rope. In considering the causes of hot boxes a great deal may be said about brasses. We have all heard a great deal of late about the electrotyping and copper spots on brasses. These are formed by the acid in the oil dissolving the copper in the brass. If for any reason the bearing gets warm, the heat draws copper and carbon to the bearing face, the journal takes up and deposits copper and carbon, which causes the copper spot and the journal becomes hot.

The following are common causes for hot boxes:

Dry and dirty packing.

Packing not touching the entire length of the journal.

Wedges working out of place.

Dust guards worn and improperly fitted, admitting dirt through the wheel plate.

Journal box lids improperly fitted and in some cases missing.

Excessive end wear on brasses, caused in many cases by improper location of the shoulder on the brass and often too much material cast in the shoulder on the brass and stop in the journal boxes.

Brasses not of proper shape; too large or too small for the journal.

Trucks out of square.

Axles slightly sprung out of a true line; principally caused by cars being derailed under load.

Journals worn concave and convex.

Wedges not fitting on the crown of brass properly, but riding on lugs of brass, causing the brass to bind and stopping the flow of oil bearings.

All second hand journals upon which new wheels are pressed should be given a lathe test, as the ordinary caliper and wheel gage test will not detect these defects in all cases.

A brass that has once run hot should be removed and relined. The practice of many roads is to give the brass a new soft metal face and apply it again. In such cases, it will run cool until the journal has worn through the babbitt face and then run hot again for the reason that, as far as the excessive degree of heat has penetrated the brass when it was first hot, the lead and zinc has been melted out. The brass is porous and the temperature uneven. A brass that has run hot may be relined and material enough added to bring it up to the standard weight at an average cost of eight cents per brass; where if the attempt is made to continue running the box with the same brass, in nine cases out of ten, the brass, worth about $2.80, is ruined, trains delayed, and in many cases the journal cut.

In preparing sponge of oil and waste for journal boxes the following rules should be observed. Soak the waste in oil at least 48 hours before using. Keepers of oil and waste who issue packing to trainmen should pick the waste apart, before applying the oil. Drain off the surplus oil, allowing sufficient to remain in the waste so that by gently pressing with the hand, oil will flow. The first waste to be introduced into the journal box should be wrung moderately dry in the form of a rope and packed up tightly under the journal and against the wheel plate or back of box This serves as a guard, excluding the dust from the outside as well as retaining the oil in the box. Then follow up with the waste out of the pail, so as to have it in a spongy condition under the journal.

In case of excessive end wear on brasses, great care should be taken in applying new brasses and in every case if there does not appear to be sufficient lateral motion between the end of the brass and the collar of the journal, the shoulder of the brass should be filed down to insure a perfect fit. Brasses are sometimes too light. Filled brasses are often weakened by drilling too large and too many holes in the crown of the brass for the purpose of holding the filling.

I also believe that many brasses that have just run warm and been removed are unnecessarily thrown away, through ignorance on account of the copper spot. I have experimented on this and found that by using a proper tool and planing off the copper spot, that the replaced brass can be worn out. It should also be remembered that the brass is for bearing. The soft metal face is to enable a journal to get a bearing quickly. I mention this from the fact that it seems to be the opinion of many of our car repairers, and in some cases others, that a brass is worn sufficiently to be removed when the babbitt face only is worn. We have comparatively few hot boxes on our babbitt or lead lining. In most cases the trouble begins when the lining has been worn through and bearing is on solid brass.

LINE INSPECTION.

A paper was presented on this subject by J. H. Callaghan, Canadian Pacific. An abstract follows:

Line inspection offers a big field for the heads of many important departments of a railway. Some lines have no less than 50 places where materials are carried, all of which come under the care of the various division storekeepers, and while these form a portion of the line inspection they do not afford anything like the field to work in which is offered by the line proper or such places as engine houses, car repair yards, bridge and building department shacks, construction yards, steamship, ferry and elevator terminals, freight and baggage sheds, etc., in fact, wherever company's material, whether new, second-hand or scrap, is apt to be found. These are the places where the general storekeeper with the inspection team can do a lot of very valuable work.

A good inspection team could be made up of the general manager, or an officer of equal rank; general master mechanic; master car builder, and the general storekeeper.

The general manager because he is in charge of all lines on which such inspections are made and decisions are arrived at on the ground. The general master mechanic because all division master mechanics are subject to his instructions. The master car builder for similar reasons, the various division car foremen being subservient to him, and the general storekeeper because he is the custodian of the company's materials, no matter where located.

On the eastern lines of the Canadian Pacific there are four grand divisions with proper complements of officers, such as general superintendent, district and assistant superintendents, division car foreman, master mechanic, etc., and assistants, car and locomotive foreman in charge of supplies, in which capacity they report to the division storekeeper all matters pertaining to the upkeep and care of the stock, so that, in making an inspection over any of these divisions a number of these officers usually accompany the above mentioned inspection team.

During the inspection the general manager on the rear end of the train, notices sign boards not properly painted, station buildings in about the same condition, cattle guards, fencing wire, switch material ties, etc., not properly cared for, and speaks to the general superintendent of the division together with the superintendent in charge of the district as to these conditions and directs as to their proper disposition. The general master mechanic notices locomotives hauling regular trains where an engine of less capacity would answer the purpose and arranges at once with the division master mechanic for the proper disposition of this misplaced power. While in the engine houses and machine shops he looks into the work of proper upkeep of machines, proper methods of general engine house practices and is constantly introducing shop kinks. The master car builder covers very much the same ground in his department.

There was a time and no doubt is yet, when officers in making inspections were frequently misinformed, when they had not the proper inspection team about; that is, they received a lot of unreliable and erroneous information simply because the information was given in such a manner that unless the officer was conversant with the details, he was liable to accept them as genuine.

The general storekeeper must satisfy the other members of the team that he is the right man in the right place, that he may be of valuable assistance to them in the various details of inspection as applies to their particular line, which in a general way is largely in common with his own, so that the assistance he renders may be mutually reciprocated. No better working inspection team is necessary for any purpose than the one with which I am connected. It is not directly with the stores department proper or material in the care of the department's employees at division or other points where the accumulations of new, second-hand or scrap materials may be found that the general storekeeper does his best work.

These latter accumulations are tabulated by the department's own men and proper record kept of them, in addition to which the department's inspectors are constantly on the line following them up, their work being mainly directed to the keeping down of surplus stock under the charge of the stores department. In visiting some section tool houses, car cleaners' shacks, etc., in unfrequented places some valuable finds are made. For example, on some of the smaller branch lines where they run a passenger train daily you may find a vacuum cleaner for the seats which is, of course, never used and the man in charge does not know what it is for, or you might find a hose for gasing cars where this operation would not be necessary once in years. Such finds are ordered shipped in to the divisional stores.

A feature of these inspection trips and one which tends to enhance their value is that meetings are held frequently of all the officers of the different grand divisions at which the inspection team aim to be present. The efforts made and results affected, particularly as applicable to the material question or work done by the general storekeeper are usually brought up at these meetings and detailed reports of such savings as have been made are usually illustrated in dollars and cents, and in reporting results of inspections in the way of saving purchases of material which are found to be unapplied at various places on your line. You cannot bring these facts home by simply describing, say 5 crossheads, 20 miles of No. 9 telegraph wire, to the same extent as you can if you say that during a certain period there has been picked up on your division material to the value of so many thousand dollars which your operating and other expenses have been credited with.

This is the sort of inspection which counts. Attach yourself to the proper team, be diplomatic and tactful, satisfy divisional officers that your efforts are intended to be helpful, earn their honest co-operation by dealing squarely with them, make clear that all material cleaned up by you is properly covered with the necessary credits resulting in reduction of cost in operating their district or division; establish this condition and you will add supporters to your good work every trip you make.

Discussion.—That line inspection is a necessity on all roads was conceded by all the members present. Various ways in which this inspection is now performed were described; some roads make two general inspections every year, while others make these inspections once a month.

While it would seem that a large road would be limited in the number of inspections possible to make, it was shown that on the Southern Pacific these inspections are made every month, although not by the general manager or by such high officers as

described in Mr. Callaghan's paper; they are represented by their subordinate or division officers. On this road a supply train made up of about eight cars runs as a special over each division every month. It is composed of supply cars and private cars to accommodate the superintendent, resident engineer, road-master, bridge and building engineers and master mechanic, together with the storekeeper. The train inspects every point and stops at each point as long as is necessary. This system has met with very good success, and it brings each local agent, foreman and operator in close touch with their superior officers on the division, and makes a much closer unit all the way through. The storekeeper becomes acquainted with different officers along the line, and this apparent support of the superintendent greatly aids him in controlling the stock to the best possible advantage. During this trip supplies are delivered and surplus stock picked up, together with any scrap that may be found along the line.

One storekeeper on a large system was ordered by his superior to spend two days in the office and four on the road. Mr. Murphy of the Lake Shore goes a little further with his inspection system and sends his men out visiting other roads, and he finds that they come back with renewed ambition and incentive and oftentimes with many valuable ideas.

In connection with the subject of surplus material, G. G. Allen, Chicago, Milwaukee & St. Paul, stated that the general or divisional storekeeper should keep as actively in touch with what is going on on the road or divisions as does the president or superintendent. In this way the storekeeper can be ready with supplies for any new work, or if a shop is transferred from one point to another can arrange to have his stock transferred with the least possible delay.

STANDARDIZATION OF GRAIN DOORS.

D. Kavanagh, chairman of this committee, reported that the committee had conferred with the committee of the General Superintendents' Association on reclamation as well as the standardization of grain doors, and with slight modifications had not found any reason to change the recommendations which were made in the previous report. It is still maintained that doors 20 in. wide by 7 ft. long are the most serviceable, and can be used in any freight car suitable for carrying grain having a standard width of door. It was agreed after conference with the committee of the General Superintendents' Association and with Mr. McNulty, the reclamation re-cooperage agent, that better results can be obtained from grain doors constructed with the two end cleats set out flush to the end of the door, instead of 6 in. back from the end as previously recommended. There is more nailing stock at the end of grain door, making it more substantial and less liable to be damaged in removing it from cars. For railways buying grain doors made of hard woods, it is not believed necessary to have a complete double door, i. e., a door made with a full double thickness of lumber all the way through, single thickness hard wood doors being equally as strong and serviceable as double doors made from soft wood, if all cracks are properly cleated.

Roads that can purchase hard wood doors to advantage, constructed as above described, will save approximately $25,000 to $30,000 a year where large quantities of these doors are required. In order to have the marking of grain doors uniform on all railways, it is recommended that on the inside the door should be properly stenciled with the initials of the railway in large letters, and also the name of the manufacturer of the grain door, this latter information for identification purposes. On the opposite side of the door, that is, the outside, should be stenciled also in plain large letters—"This Side Out—Return to A. B. & C. R. R."

HANDLING AND ACCOUNTING FOR MATERIAL AT CONTRACT SHOPS.

When equipment is to be repaired under a contract, care should be taken to see that the contract is practical. The accounting, mechanical and supply departments should draw up the contract between them and it should be carefully studied by the accountants, inspectors and checkers assigned to the particular job. As the equipment is received at the shop it should be examined by the inspector with the assistance of the checker and his report should be made in duplicate, one for the contractor and one to be used in checking up new material as it is received. Definite prices should be agreed upon for any piece work done on the equipment and the price of the material, if any, furnished by the railway should also be fixed. It would be best to have all or none of the material purchased and furnished by the railway and still better for the contractor to furnish it all. When the railway company furnishes the material a complete store organization should be maintained by it at the contractors' shops. In this case all material should be double checked and the inspectors should watch for wasted material and scrap.

OTHER BUSINESS.

Among other papers presented was a report of the accounting committee, which requested more time in which to make a comprehensive report. The stationery committee, H. E. Rouse, Chicago Great Western, chairman, gave a report of progress and was continued for another year. This committee has done considerable hard work, and as the subject is such an extensive one it cannot be adequately handled in one year. A very able paper was also presented by H. C. Pearce, Southern Pacific, on increased efficiency in the supply department.

Concerning assembled shipments of material, the concensus of opinion seemed to be that for requisitions for five-car lots or under they should be shipped assembled, although no iron-clad rules could be laid down. Assembled shipments allow the work to be properly begun, limit the misapplication of material, limit the liability of stealing and save in the handling of the material.

The new officers were elected as follows: J. R. Mulroy, St. Louis & San Francisco, president; J. W. Gerber, Southern Railway, first vice-president; G. G. Allen, Chicago, Milwaukee & St. Paul, second vice-president; J. P. Murphy, Lake Shore & Michigan Southern, secretary and treasurer.

THREE-CYLINDER SIMPLE LOCOMOTIVES

Twenty Atlantic type locomotives recently built by the North British Locomotive Company for the North Eastern Railway of England are of the three cylinder simple type. Ten of them, built for saturated steam, have 15½ in. x 26 in. cylinders, and the remainder, equipped with Schmidt superheaters, have 16½ in. x 26 in. cylinders. They have been very successful in handling trains of from 300 to 500 tons behind the tender at average speeds of 53 miles per hour. They have 82 in. driving wheels and 27 sq. ft. of grate area. The total weight in working order is 153,400 lbs. Each of the three cylinders has its own piston valve operated by a Stephenson valve gear. The three cylinders and valve chambers are all in one casting and the valves for the two outside cylinders are located inside the frames about on the same horizontal line with the cylinder; while the center valve is in an inclined position over the center cylinder. All cylinders drive on the front pair of drivers, which has a cranked axle. The cranks are set at an angle of 120 deg. with each other. The steam pressure unfortunately is not given in the description of these locomotives in the *Engineer* (London), from which this information is taken.

Accidents.—A reduction of 29 per cent. in the number of accidents during 1911 as compared with the year 1910 is reported by the Illinois Central. In 1911 there were 269 accidents on the road as compared with 380 in 1910.

ANNUAL MEETING OF AIR BRAKE ASSOCIATION

Convention Report, Including Papers and Discussions on Hose Failures and on Wear of Shoes as Affected by Wheel Loads.

The nineteenth annual convention of the Air Brake Association was held at the Jefferson Hotel, Richmond, Va., May 7-10, W. P. Huntley, general foreman of the Chesapeake & Ohio at Ashland, Ky., presiding. Governor William Hodges Mann welcomed the convention to Richmond. Addresses were also made by W. H. Adams of the Board of Aldermen, T. M. Carrington of the Chamber of Commerce, and M. J. Capler, fourth vice-president of the Chesapeake & Ohio.

THE JOB BEHIND THE CLEANING DATE.

After the opening exercises a paper on The Job Behind the Cleaning Date, by C. P. McGinnis, was read by his successor on the Soo Line, H. A. Clark. It relates to the remarkable results accomplished by Mr. McGinnis, in the past two years, in improving the air brake service by careful inspection of the freight brake equipment, systematic testing and cleaning of triples and brake cylinders, and the providing of proper facilities for the purpose. This work has proved so important that representatives of other lines have gone to the Soo yards to inspect and study the methods used.

In the discussion the Pennsylvania method of testing the leakage of brake cylinders by gage and limiting the leakage to 5 lbs. per minute was generally commended; this practice is extending to other lines and its general adoption was strongly urged. It is difficult to comply with federal laws relating to air brakes and maintain 85 per cent. of the brakes on a train in good order without a well organized system of tests and inspection.

LIGHT AND LOADED AIR BRAKE EQUIPMENT.

W. V. Turner, of the Westinghouse Air Brake Company, gave an illustrated lecture on Recent Air Brake Developments. It dealt more particularly with the improved brake for light and loaded freight cars, and excited such unusual interest that this brake equipment will probably come into more general use.

Discussion.—C. C. Farmer described the successful operation of this system on the Bingham & Garfield in the copper region of Utah. Here 40 loaded cars weighing 3,040 tons are handled safely on a 16 mile grade, 3.2 per cent. maximum. The operation of the trains was one of the most difficult problems encountered by the air brake company. This equipment has also been applied to 500 cars on the Denver, North Western & Pacific, and there are a few in use on the Santa Fe, the Baltimore & Ohio, and the Southern Pacific. Representatives from these lines reported it working successfully and without any unusual difficulties On account of its great advantage in increasing the percentage of brake power to the weight of the train it is expected that the use of this brake will extend to lines in level districts as well as on the heavy mountain grades, and it will be especially useful on 50-ton coal and ore cars.

AIR HOSE FAILURES.

Following is an abstract of a report on this subject which was made by a committee of which T. W. Dow was chairman

The large increase in the number of air hose that blow off the fittings and burst, with the consequent serious detentions, and in some cases bad wrecks, has emphasized the fact that the subject is much more important than it has yet been considered. While there has always been more or less of these failures, the trouble has increased several fold during the last two or three years; on one of the large trunk line railways the matter became so serious during the summer of 1911 that a special soap-suds test of all air hose on all freight trains at all terminals was ordered, with a view of determining the exact conditions. The result was most surprising, even to those who knew something of the trouble. Not only were an excessively large number of porous hose found and removed from its own cars, but an equally large number were removed from foreign cars as well. The cars of practically all railways were handled during the time of these tests, and none were found free from the defect; without doubt the trouble is not a local one, but general throughout the country.

Many suggestions as to the cause of these failures have been offered, but as yet no remedy has been found. To whatever cause the difficulty may be attributed, one thing is certain: the failures during the hot, dry summer weather are far in excess of those during the cold months, so far as the bursting and blowing off of the fittings is concerned.

At one time good Para rubber was largely used in the manufacture of air hose, but it is claimed that since the general introduction of the automobile, the greater part of this good rubber is used in tires, and that Mexican, or some other poorer substitute, has been used for hose. This is refuted by the manufacturers, and it is claimed that the low price paid for the air hose is responsible for the poor quality, and that there is plenty of Para rubber for all purposes, if it is desired.

Many failures of air hose can still be traced to the wrong practice of pulling the couplings apart instead of separating them by hand; while improved couplings may have to some extent reduced this trouble, much of it yet remains. Also, where some of the improved couplings have been struck and distorted, the force necessary to separate them seems to be about as great as with the old type. Could this practice be stopped, many failures would be eliminated, but good results cannot be obtained by a few roads stopping it and many others permitting it to be done. It must be by a general co-operation of all roads.

A great deal more trouble was experienced during the severe cold weather of the past winter with what are termed frozen or stiff hose than ever before; it would appear that this, too, was due, in some manner, to the make-up of the tubing; also to some extent to the moisture contained therein; many cases were encountered where the leakage was so great that both passenger and freight trains were stalled, the hose in some cases parting entirely.

There is no doubt but that pure Para rubber is but very little used in air hose, and it is known absolutely that the make-up of the rubber tubing is not as good as that of several years ago; yet, at the same time it is known that the manufacturers can furnish a hose that will stand the tests required by the Master Car Builders' Association. Further, it is not believed that such requirements are severe enough. It has been suggested that a higher tensile strength of the inner tube be required, and it is believed that this would make a decided improvement, as tests made with some of the present make, that have been but two or three months in service, developed numerous pin holes, which no doubt account for the large number of cases of burst and porous hose that are comparatively new.

Your committee is of the opinion that the only hope for improvement rests in a better quality of rubber tubing throughout; enough has been learned to lead the committee to think that such improvement cannot be obtained at the present price paid for the hose. It is admitted by manufacturers that the strength of air hose has, to some extent, been sacrificed in obtaining the friction required by the specification of the Master Car Builders' Association, inasmuch as a loosely woven duck has to be used; if a tighter woven duck could be used the

strength would be increased, although the friction might be decreased.

Every effort should be made to discourage the use of hose purchased only on specifications, as the manufacturers can furnish hose to meet said specifications without any regard to what life will be obtained from the material in service. On the other hand, better results will be obtained by securing the hose on a service basis, as can be easily arranged for.

Another recommendation has been made looking toward the advisability of making up a hose so that the pressure resistance can be materially increased by the use of a lighter weight duck and an increase in the number of ply. It has been suggested by an expert that a more homogeneous pressure resistance effect can be obtained with 8-ply and 8-oz. duck than with 4-ply and 16-oz. duck. Such a hose should be held together with a very high-class friction, and should be easily pliable at low temperature; i. e., zero or below. It is further believed that such a hose would give less trouble from pulling off the fittings on account of there being more canvass and less rubber under the hose bands.

The statement has been frequently made that it would be of little use for a few roads to purchase the best quality of air hose while the majority did not. There must, therefore, be some means devised to secure a hearty co-operation on the part of all, and it might even require a special ruling on the part of the Master Car Builders' Association to bring this about.

Whatever may be the outcome, the manufacturers will welcome the privilege of supplying a more serviceable grade of hose if the consumers are willing to pay the price. It is up to the consumers to outline reasonable requirements and to demand of the manufacturers hose to meet them.

Discussion.—Part of the discussion related to the hose blowing off of the nipple, but the principal interest was attached to the quality of the hose. In passenger service, with long cars and short cross-overs, there is such a large lateral movement of the car ends that the hose is pulled off, even with proper holders which provide for a free lateral movement. Some lines limit the service of passenger brake hose to six months, and it is then used in freight service; others make a longer limit and then scrap the hose entirely. They also test the hose on passenger engines with soap suds daily.

The northern lines still have trouble from rigid hose in very cold weather, and it is often necessary to remove hose from freight cars after six months' service in severe winter weather. The inferior quality of the rubber, especially that in the inner tube, was discussed at length, and it was generally admitted that the price usually paid was too low to secure rubber of good quality.

The M. C. B. specifications should be revised in several particulars, especially in requiring a high tensile strength for the rubber, so as to more effectually exclude poor rubber. Metallic coverings for air hose were approved by some, and by others it was even suggested that a complete metallic flexible coupling be used for passenger cars instead of rubber hose. Considering the short life of rubber and the expense for hose of good quality, it is possible that a metallic pipe union would prove economical in the end. Attention was directed to the importance of storing hose in a dry place where the temperature is not too high.

UNDESIRED QUICK ACTION OF FREIGHT TRIPLES.

J. W. Walker read a paper on this subject in which he analyzed the cause of the trouble known among trainmen as "kicker," "snapper" and "dynamiter," due to the emergency application when service stops only are desired. The numerous causes of the abnormal action of the triple, because the auxiliary reservoir pressure cannot reduce as fast as the brake pipe pressure falls, are listed on the chart below.

Weather conditions:
- Unequal expansion of different metals.
- Freezing of moisture.
- Gumming up of excess lubricant.

Lubricant:
- Too heavy.
- Too much used.

Feed valve:
- Sluggish.

Engineer's brake valve:
- Condition of—
  - Preliminary exhaust port too large.
  - Equalizing piston:
    - Dirty.
    - Gummed up.
    - Tight.
  - Conical end of piston stem filed off.
  - Removal of exhaust fitting.
- Manipulation of—
  - Lap, allowing brake pipe leakage to
    - Apply brakes.
    - Open graduating valve.
  - Partial emergency position used for service.
  - Too light preliminary reduction.

Equalizing reservoir:
- Leaky.
- Volume reduced by water, etc.
- Too small.
- Choked passage between equalizing piston chamber and equalizing reservoir.

Brake pipe:
- Leaky.
- Long.

Conductor's valve:
- Attempted service application with.

Triple valve:
- Restricted service port in body or passage to brake cylinder.
- Restricted service port in slide valve.
- Dirty.
- Gummed up.
- Excessive friction of slide valve.
- Tight piston.
- Restricted feed groove.
- Piston makes tight seal on bush.
- Gum on piston bevel.
- Graduating valve spring catching in bush.
- Weak graduating spring combined with excessive friction.

Piston travel:
- Short.

Most of these causes can be removed if the brakes are properly maintained. The paper describes a device for locating triples which produce undesired quick action, the invention of C. L. Courson. It consists of an indicator placed between two hose couplers, so as to couple in the train line. When several of them are placed in a train line and brakes are applied, the needle on all the indicators will point in the direction from which the quick action started, and by a process of elimination the defective triples are located.

Discussion.—It was generally agreed that the use of dry graphite as a lubricant for the triple slide valve was the best remedy and has overcome most of the trouble so far as it relates to the triple itself. Air brake students are of the opinion that triples should be so improved that these difficulties will be removed and Mr. Turner, of the Westinghouse Company, said that that company had designed an improved triple which would not apply the emergency unless desired.

FRICTION AND WEAR OF BRAKE SHOES AS AFFECTED BY THE WHEEL LOAD.

R. C. Augur, engineer of tests, American Brake Shoe & Foundry Company, read an elaborate report on this subject. The first part of the paper gave an interesting historical account of brake shoe tests and of brake tests. It showed the loss in efficiency by increased brake shoe pressure and included diagrams illustrating the present conditions in express passenger service. The author proposed a rational sliding scale for proportioning the braking power, the development of which is as follows:

The time has come when a sufficient mass of positive and usable data have been accumulated to enable us to say that the method used for so many years of proportioning braking power on passenger cars to 90 per cent. based on a brake cylinder pressure of 60 lbs. is no longer tenable and must become obsolete in the immediate future. Even though our methods have given good results in the past under other conditions, the situation today has so changed that practice must now be made to agree with known facts. If we wish to operate our passenger

trains with smoothness and safety we must adopt a rational sliding scale for proportioning the braking power.

Diagram 1 shows the amount of braking power required to make machine test stops from a speed of 60 miles per hour in a certain distance with different wheel loads. These curves will vary, of course, with different shoes, and had shoes of lower frictional qualities than plain cast iron or Diamond "S" been used, they would have been further to the right and have

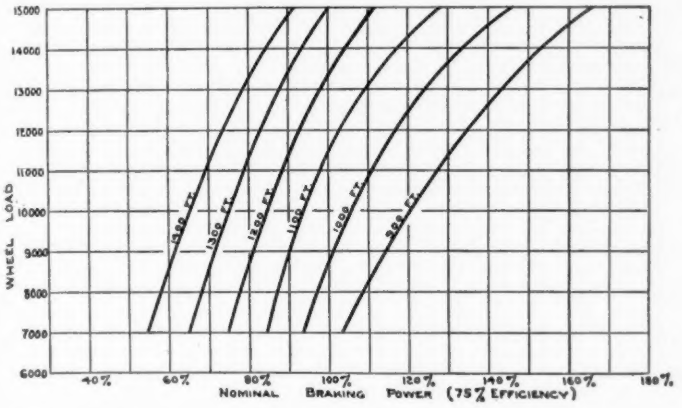


Fig. 1—Braking Power Required to Make Stops from 60 m. p. h. for Various Wheel Loads; Steel Tired Wheels.

shown the necessity of higher percentages of braking power for the same length of stop. The general character of the curves would have been the same, however. Similar curves for stops from a speed of 40 miles per hour might have been included, but they would not have brought out the facts any clearer as the angle of slope is essentially the same, although the distances in feet are less.

Diagram 2 shows the percentages of braking power which are necessary to insure essentially the same retarding force or length of stop with cars of different weights. To illustrate the way the diagram should be used we will assume that we have an eight-wheel coach weighing 69,000 lbs. By consulting the diagram we find that the braking power should be 110 per cent. If, on the other hand, we had an eight-wheel coach weighing 104,000 lbs., we find that the diagram calls for 146 per cent.

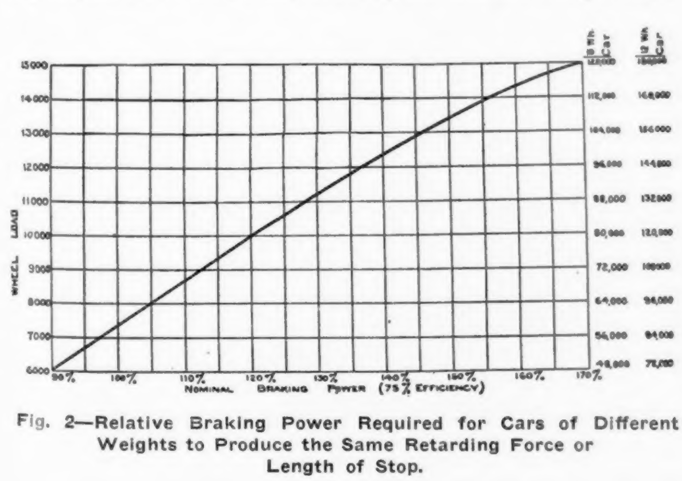


Fig. 2—Relative Braking Power Required for Cars of Different Weights to Produce the Same Retarding Force or Length of Stop.

braking power. By adopting a sliding scale such as this in proportioning braking power for passenger cars, stops will be shorter and smoother, while the danger of the wheels sliding under abnormal conditions will be decreased. These are features appreciated by the traveling public, and are also desirable from the viewpoint of the air brake and the transportation departments.

The results shown on Diagram 2 can be expressed very nearly by the following formula, the assumption being made that 90 per cent. is a satisfactory braking power for the light cars having a wheel load of 6,000 lbs.

$$\text{Percentage of Braking Power} = 90\% + \left\{ \frac{\dfrac{\text{Weight of car}}{\text{No. of wheels}} - 6{,}000}{100} \right\}$$

Stated in another form, this means that for every 100 lbs. increase in wheel load in excess of 6,000 lbs., an addition of 1 per cent. braking power should be made. In calculating braking power for baggage cars it is desirable to add 15 per cent. to the weight of the car for the load carried, and base the braking power on the assumed loaded weight.

In all of this discussion we have not referred to the acknowledged advantage of having the emergency braking power in excess of that used in service application. This difference is desirable on all weights of cars, but is of increasing importance with very heavy equipment. What we have desired to emphasize is that the braking power should be proportioned in accordance with the laws of brake shoe friction and that this calls for increasingly higher percentages of braking power as the car weights are increased.

While the subject of brake shoe friction is a vital one in connection with the design of car brakes, the rate of wear of brake shoes is one that is ever with us, as it affects operating costs. In the effort to obtain increased durability and consequently reduced costs, there has been a marked tendency on the part of many roads to use shoes of rather low frictional properties, not realizing that the saving is more apparent than real. On the other hand some of our largest systems appreciate the fact that brake shoes are used to do work, that other things besides durability are essential and that they are not applied simply as ornaments or to permit cars to be interchanged. If the work is done shoes will wear out and all that we should ask is that they render a good return for the investment. It is not the part of wisdom for a road to apply the latest improved brake mechanism and increase the braking power so that good stops can be made and then defeat what has been gained by selecting brake shoes solely because of their durability.

The whole subject of brake shoe wear is an interesting one which we shall not be able to touch on at this time. The rate of wear as well as the friction of the shoes is affected by several factors. As many of us have observed the same kind of shoes will often wear much longer on some cars than on others. This may be due to the frequency of the stops, the average running speed of the train, the weight of the car, or other factors.

The rate of wear for service tests is very generally calculated in pounds per thousand car miles. In machine tests it is usually expressed in pounds per 100,000,000 foot-pounds of work done, this expression being the one used by the M. C. B. committee in their reports. The rate depends mainly upon the following factors: Design of brake shoe; kind of wheel; initial speed; shoe pressure; wheel load.

In a general way it can be stated that any increase in speed or anything that increases the shoe pressure or rate at which work is done will increase both the actual amount of brake shoe metal worn off and the amount for doing a certain quanity of work.

The M. C. B. specification calls for the loss of metal per 100,000,000 foot-pounds of work not to exceed 0.8 lbs. for tests on a cast-iron wheel made at a constant speed of 20 miles per hour, application about one minute and release about three minutes with a shoe pressure of 2,808 lbs. On a steel-tired wheel, however, with stops from a speed of 65 miles per hour and a shoe pressure 12,000 lbs., the loss is specified not to exceed four pounds.

Some interesting data relative to the effect of conditions on brake shoe wear can be obtained from the M. C. B. report for 1910. Averaging results for all of the metal shoes we find that

on the Purdue machine the wear per 100,000,000 foot-pounds of work was as follows:

Iron wheel, 20 miles, 2,808 lbs. pressure	0.58 lbs.
Steel wheel, 20 miles, 2,808 lbs. pressure	0.75 lbs.
Steel wheel, 65 miles, 12,000 lbs. pressure	3.00 lbs.

This shows, first, that when steel wheels are substituted for chilled wheels in freight service the rate of shoe wear will be increased, and second, that higher speeds and pressures greatly increase the rate of wear.

Turning now to the M. C. B. 1911 report, we find that tests were made on the same machine at a speed of 80 miles per hour with pressures ranging from 12,000 lbs. to 20,000 lbs. Averaging results, we find that the rate of wear under the various pressures was as follows:

12,000 lbs. pressure	3.41 lbs. wear
14,000 lbs. pressure	3.48 lbs. wear
16,000 lbs. pressure	4.08 lbs. wear
18,000 lbs. pressure	5.00 lbs. wear
20,000 lbs. pressure	6.70 lbs. wear

The general average was 4.53 lbs., or 50 per cent. more than tests made during the previous year at 65 miles speed, 12,000 lbs. pressure.

Numerous other instances might be cited to show the effect of increased speed and pressure upon the wear of the shoes, but one or two will be sufficient.

In the series of tests referred to in connection with the subject of friction it will be remembered that wheel loads were used which were approximately those for 60,000 lb., 90,000 lb. and 120,000-lb. cars with four-wheel trucks. Comparing wear for stops from 40 miles per hour with those from 60 miles per hour, we find that on the lightest car the rate of wear per 100,000,000 foot-pounds of work was practically the same, that for the medium weight car it was 12 per cent. more at the higher speed, while with the heaviest car it was 42 per cent. more. The work done in stopping from a speed of 60 miles is 2.25 times that in stopping from 40 miles. This means that the actual amount of metal worn off from the shoes on a 90,000-lb. car at a 60-mile stop is 2.5 times as much as from a 40-mile stop, while with a 120,000-lb. car it is 3.2 times as much.

Take another example from the same series of tests, stops being made from a speed of 60 miles per hour. A 60,000-lb. car braking at 90 per cent. had a shoe wear of 1.35 lbs. per 100,000,000 foot-pounds of work, while a 120,000-lb. car, braked at 125 per cent. and stopping in practically the same distance, had a rate of wear of 2.45 lbs., or 81 per cent. greater. The heavier car, however, weighed twice as much and required twice as much work to stop it; this means that on the heavier car the actual amount of shoe metal worn off was 3.6 times as much as on the lighter car.

In view of such facts is it any wonder that railways are finding that the expense for brake shoes for their heavy passenger cars is large and that there is need for shoes which will give good durability without the sacrifice of frictional properties?

The first essential in railway operation is safety, the second is economy. We have seen how in the struggle to retain safety the changing conditions have necessitated greatly increased brake shoe pressures, and that if the question of safety was given the attention it should have, many of our large roads would be obliged to use higher shoe pressures than they now are. While the brake shoe has been steadily improved and has been able to meet the changing conditions and stand up under the severely heavy modern requirements, it has been done at a marked increase in the rate of wear, even though considerable has been accomplished in the direction of increasing the brake shoe durability.

Personally I feel that we are going beyond shoe pressures which are good practice. It is self-evident that anything that will enable us to make the desired stops without such high pressures would be desirable inasmuch as lower pressures mean a greater coefficient of friction and a lower rate of wear. At the present time one or two of our important roads are trying the experiment of clasp brakes. As this seems to be the most practical scheme for obtaining reasonable brake shoe pressures the results obtained will be watched with considerable interest by all of us.

Discussion.—The paper was discussed at length by S. W. Dudley of the Westinghouse Air Brake Company, who showed that while 90 per cent. of the brake power was applied to the shoe only 10 per cent. was realized in efficient work in stopping the train, and the principal loss was due to the brake shoe. The co-efficient of friction which is usually only 10 to 12 per cent. in passenger service, was the real measure of brake efficiency and some improvement should be made in the methods of brake shoe application to increase the efficiency.

W. L. Burton, of the Westinghouse Air Brake Company, then described verbally the clasp type of foundation brake gear for heavy passenger cars, and presented drawings of such gear as applied to four and six-wheel trucks on the Philadelphia & Reading. This gear has been in successful use on that road for about two years, and a service of 12,500 miles per brake shoe is obtained. The total leverage is 9 to 1, and as the usual load on the brake shoe is divided by two the wear is reduced and there is much less heating of shoes than where only one shoe is used per wheel.

W. V. Turner regarded these two papers—that of Mr. Augur and of Mr. Burton—as so important that the subject should be followed up, and it was decided to appoint a committee to further develop the proposed improvements, and report next year.

WESTINGHOUSE PC EQUIPMENT.

Thomas F. Lyons, of the Lake Shore & Michigan Southern, read an extensive paper on this subject in which he brought out the results obtained from the PC equipment in road service in the past few years, and explained in a general way the proper methods of train handling and the care and maintenance of the equipment. In closing he said:

"In conclusion it can be said that the PC equipment has fulfilled all the requirements laid down after the Toledo tests by the air brake supervisors of the New York Central Lines, and also that it does accomplish what was required by the railroad conference held in Pittsburgh in 1909.

"It is essential, however, that the truck and foundation brake gear be of such a design as to withstand the enormous pressure developed by the PC equipment. If this is done, it will only be necessary to state what stopping distance is required above 800 ft. at 60 m. p. h. in order to have it accomplished. As the matter now stands we cannot be sure whether the forces developed are being applied properly or not; that is to say, the trucks tilt, changing the weight on the wheels more or less, the springs are pulled down together, there is longer piston travel, and in various ways the forces are distributed in a detrimental manner. This, of course, largely defeats the object and may result in abnormal stresses in the train, flattening of wheels, etc.

"There can be no question but that the PC equipment will meet all the requirements of service braking and develop all the force required for emergency; but for these features to operate effectively, it is essential that it should have the proper foundation to work upon, and for this, it is not out of place to ask this association to put forth its best efforts to secure such truck and foundation gear design as will meet the requirements."

Discussion.—The discussion related principally to the manner in which the engineers reduced pressure in applying the brake when the PM and PC brakes were mixed in a train. Much of the difficulty from the flat wheels was due to improper application, and in not carefully following the instructions for the use of these brake equipments.

PIPE AND PIPE FITTINGS.

P. H. Donovan read a paper on this subject which related more particularly to the air brake piping on locomotives. It gave the results of an exhaustive investigation made by the Westinghouse Air Brake Company to determine the effect of elbows and pipe fittings on the service operation and quick action of the brake. It was shown that the ordinary data relating to air transmission in pipes does not apply to brake operation and is misleading if so applied. To secure proper brake action the pipes and fittings must be such as will insure a drop of pressure in the brake pipes at the rate of 8 lbs. per second. Following are the important conclusions which the author drew from the results of the experiments:

First, that the service operation of the brake is not seriously affected, either by size of pipe or number of elbows, whatever effect does occur being merely that due to volume and not resistance to movement.

Second, the question considered in this paper, therefore reduces to one of the effect of piping or elbows upon initiation and propagation of quick action.

Third, it is necessary to have a quick action valve or venting device located so near the brake valve and so near the following quick action device, as will insure the drop of pressure in the brake pipe at the rate of 8 lbs. per second, and that this rate occur while the quick action device is in release position.

Fourth, if the preceding conclusion is accomplished it is immaterial as far as quick action is concerned, whether the piping is long or short, or whether many or few elbows are employed.

Fifth, as it is important, however, that the time of transmission of quick action throughout the train be as short as possible, and as length of pipe adversely affects this by added volume and some slight resistance, and elbows by resistance and a slight increase in volume, it is desirable to keep both to a minimum.

Sixth, whenever the length of pipe, that is, volume of the brake pipe, can be reduced by the use of an elbow, it is preferable to use the elbow.

Seventh, that the deductions and rates made from experiments and experience in air transmission do not apply to a brake operation, and are misleading if employed in this connection, as here volume is the chief factor to be reckoned with, at least within the limit of present methods of installation.

Eighth, that with the conditions of long locomotives, double heading, the complexity of piping that goes with this, in combination with long trains, one quick action device per locomotive is not sufficient to insure the propagation of quick action; in other words, one quick action device per locomotive is not sufficient to secure the required drop of 8 lbs. per second on the first car.

Ninth, that a quick action device operated, by a fixed and invariable volume is preferable to one that is operated by a variable volume.

Tenth, that a quick action device governed entirely in its operation by rate of reduction is preferable to one whose operation is contingent upon, or varied by, the rate of reduction and resistance to movement.

Eleventh, that when triple valves are used, the rate of fall of brake pipe pressure must exceed 8 lbs. per second if the triple valves have been caused to assume or stop in service position before quick action reaches them.

Twelfth, that the volume, that is size, of auxiliary reservoir is a material factor in producing quick action with a triple valve, for the reason that the greater the volume the more extreme adverse conditions may be before quick action fails to take place.

Thirteenth, that to insure propagation of quick action in a long train, it is necessary (as near as we could determine for each 600 cu. in. of brake pipe volume, to suddenly open at least a ½ in. outlet to the atmosphere, it being understood that the quick action device is located about the center of this 600 cu. in. volume.

Fourteenth, that elbows and length of pipe, "per se," are not the most important factors; that is to say, it will generally be found, when quick action fails, that it is due to other causes than these, for example, unnecessary restrictions in the piping, such as fins, use of unions with small passages, kinks in the hose, pipe screwed too far into tees or elbows, etc. Also any and all the circumstances and conditions mentioned in the previous conclusions; in other words, it would be a mistake to give consideration to elbows only as though their elimination would be a panacea for quick action failures.

To conclude, the writer would recommend that the foregoing conclusions be considered the real test for all locomotive brake installations, including piping, the type of locomotive and service conditions for which it is intended, determining the design that should be applied.

AN APPRECIATION.

The executive committee presented the following resolution relating to W. V. Turner, which was unanimously adopted:

"Resolved that as Mr. Walter V. Turner, chief engineer of the Westinghouse Air Brake Company, has devoted so much of his time and efforts towards the welfare and usefulness of this association, it is the sense of this association that a suitably engrossed resolution of appreciation be presented to Mr. Turner as a tangible recognition of our esteem and of his ability and genius."

In response Mr. Turner gave an interesting account of his career in connection with his work in developing air brake equipment.

OTHER BUSINESS.

Brief addresses were made by J. F. Walsh, general superintendent of motive power of the Chesapeake & Ohio, and J. E New of the Norfolk Southern.

The following officers were elected: President, H. A. Wahlert, Texas & Pacific; first vice-president, W. J. Hatch, Canadian Pacific; second vice-president, L. H. Albers, New York Central; third vice-president, J. T. Slattery, Denver & Rio Grande; secretary, F. M. Nellis, Westinghouse Air Brake Company; and treasurer, Otto Best, Nathan Manufacturing Company. St. Louis was selected as the place of meeting for next year.

SELF-CLEARING ORE CAR

A self-clearing, quick-dumping ore car, built by the Pressed Steel Car Company, Pittsburgh, Pa., and specially designed for use in the ore trade in the northwest is shown in the illustrations. The primary object was to produce a self-clearing car which would discharge its entire lading between the rails, practically instantaneously on opening the doors, without leaving any ore inside the car, which would have to be removed by digging, shoveling or other laborious methods, as is almost invariably the case with the ordinary type of drop bottom ore car. The general dimensions and data for these cars are as follows:

Length inside of the body	18 ft. 1¾ in.
Width inside of the body	8 ft. 6½ in.
Width over side sheets	8 ft. 7 in.
Length over ends	22 ft. 0¼ in.
Height from rail to top of body	9 ft. 6 in.
Distance from center to center of trucks	14 ft. 8 in.
Length of drop door opening, at center, 5 ft. 7½ in.; at sides	8 ft. 0½ in.
Width of drop door opening	6 ft. 6½ in.
Cubic capacity, level	705 cu. ft.
Cubic capacity, level 10 ft. average heap	834 cu. ft.
Weight of car body	16,700 lbs.
Weight of trucks	15,800 lbs.
Total dead weight	32,500 lbs.
Ratio of lading to total weight of car when loaded	77.2 per cent.

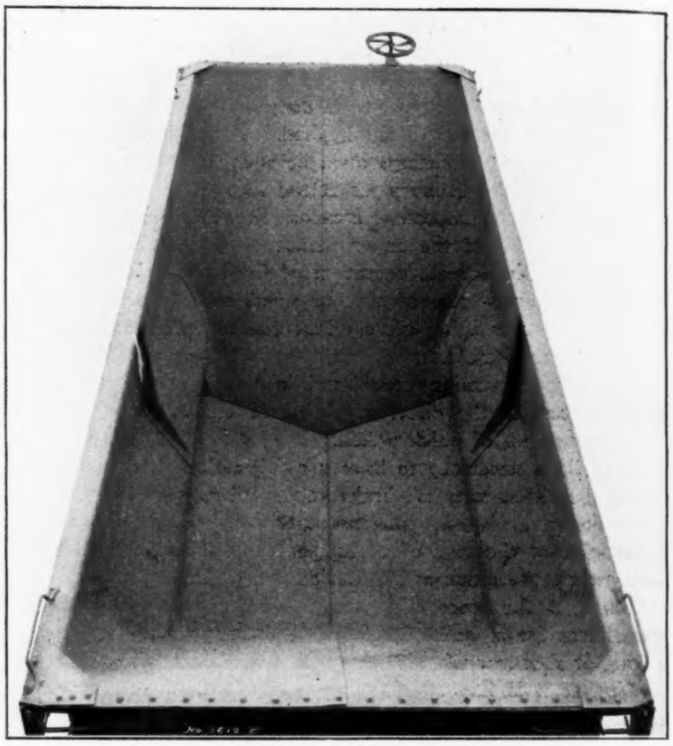
These cars have the largest unobstructed door opening that it is practical to obtain. The hopper floor sheets have a slope of 50 deg., and the hopper side sheets 60 deg., insuring free and easy movement of the lading. Two doors, one hung from each

side of car, are operated by an adjustable self-locking safety device, which is positive in its action and will prevent the operator from being injured through carelessness or inexperience in operating the doors. The mechanism can be operated easily by one man and the time consumed in opening the doors, dropping the load and closing the doors again in actual servive has been as low as one and one-quarter minutes. The doors are supported by cranks which turn over a dead center into a position of rest, so that no load is supported by the gears or by ratchet locks. To dump the cars the cranks are merely tipped over the dead center, after which the weight of the lading sends the doors down with a rush and sufficient shock to materially aid in detaching any of the lading which may tend to stick to the inside sheets.

The doors are connected to the cranks by heavy rods with screw adjustment, so that they may readily be maintained tight; there can be no stretch or give in these rods, as is the case with chain construction. This insures the doors remaining tight and close, and that there will be no leakage of ore in transit. Another advantage in this rod connection is that if the doors are frozen up in handling frozen ore, so that they will not drop by gravity, they can be forced down by these rods; this cannot be done with a chain connection.

The doors have been made stronger and are more heavily braced, than has been the practice in the past, to prevent distortion and damage from loading with steam shovels, under which hard usage it is difficult to keep the doors in good shape. The crank shafts at either end of the doors are equipped with segmental gears, connected by means of a rack gear along the side of the car, which insures perfect unison of action at each end of the door, both in opening and closing it; also does away with the use of chains, as applied to some of the earlier cars of this type. There is also an auxiliary latch which operates on the rack gear as an extra precaution to avoid accidental opening of the doors.

The general design of the car is in accordance with the best modern practice, every detail having been worked out with care to secure maximum strength and highest efficiency. The distribution of material is such as to give lowest possible weight for safely carrying 50 tons of ore and providing the necessary construction to make the car discharge its load freely. Material has been liberally used where necessary to insure the car operating with a minimum cost for maintenance and operation.



Interior of Self-Clearing Ore Car.

The trucks are of the arch bar type with 5½ in. x 10 in. journals and have pressed steel bath tub type bolsters and pressed steel brake beams. Several hundred cars of this type have been in service on the Duluth & Iron Range, and the Duluth, Missabe & Northern for over a year, and have given satisfactory results.

Steel Self-Clearing, Quick-Dumping Ore Car for the Northwest.

TESTS OF JACOBS-SHUPERT FIREBOX.

A progress report of the comparative tests being made at Coatesville, Pa., between two boilers, one with a radial stay firebox, and the other with a Jacobs-Shupert firebox, has been made by Dr. W. F. M. Goss, under whose direction the work is being conducted. This report is as follows:

"The tests of Series A, have been entirely completed, with results which in general terms are set forth below.

The Boilers.—"Both boilers are identical in their general dimensions which are as follows:

Outside diameter of shell of boiler at front end	70 in.
Diameter of shell at throat	83⅞ in.
Number of 2¼-in. tubes	290
Length of tubes	18 ft. 2 in.
Inside length of firebox	109⅝ in.
Inside width of firebox	76⅜ in.

"The purpose of the tests of Series A was to determine for each boiler the evaporation from the firebox and from the tubes separately. To make such a determination possible, the back-tube sheet was extended in all directions to the outside of the boiler, thus forming a diaphragm completely separating the water-space on the two sides of this tube-sheet. By this device each boiler was made in effect two boilers, the heating surface of one being all portions of the firebox, excepting the front tube-sheet, and the heating surface of the other being the tubes and tube-sheets.

"In carrying out the tests, each compartment was supplied with weighed water as though it were a separate boiler. The quality of the steam delivered from the firebox end and from the barrel end was determined independently, the purpose being to determine with the highest possible accuracy the heat delivered through the walls of the firebox and the heat delivered through the flues. The heating surface of the two boilers is as follows:

	Radial-Stay Boiler.	Jacobs-Shupert Boiler.
In the firebox	179.2 sq. ft.	201.9 sq. ft.
In the barrel	2,805.1 sq. ft.	2,806.5 sq. ft.
Total for both parts of the boiler	2,984.3 sq. ft.	3,008.4 sq. ft.

Tests with Oil.—"A series of oil-fired tests have been run on each boiler. Three different rates of power have been employed in each series, the rate of fuel consumption ranging from 800 lbs. to 2,100 lbs. of oil per hour. The total water evaporated from both the firebox end and the tube end of the boilers has ranged from 10,000 to 24,000 lbs. per hour, the evaporation per pound of oil being approximately 16 lbs. in the tests of lowest power and 14 lbs. in those of highest power. In all tests a surprisingly large percentage of the total work was done by the firebox. This percentage was greatest when the rate of power was lowest. Speaking in general terms, at low rates of power from 45 to 50 per cent. of the total heat transmitted by the boiler is absorbed by the firebox. With increase of power the percentage falls, but the lowest value thus far obtained is approximately 34 per cent.

"As the heating surface of the firebox is a comparatively small fraction of the total heating surface of the boiler, it is evident that heat is transmitted from the firebox at rates which are extremely high. For example, results of a number of tests show the evaporation of more than 50 lbs. of water per square foot of firebox heating surface per hour, which rate of evaporation is equivalent to the development of more than 300 horse power to the firebox alone. In estimating the significance of these results, it should be remembered that in the experiments, the firebox virtually constituted a boiler by itself, that it had no more water about it than the normal locomotive firebox, and that it could not benefit by the circulation of water from the forward end of the boiler backward into the water legs. The fact that fireboxes subjected to such conditions could be worked at the rate of power stated, is suggestive of new possibilities in boiler design. The full development of these data will make of record facts with reference to the distribution of work between the firebox and tubes of a modern locomotive boiler which have never before been determined.

"The experimental results have not yet been sufficiently studied to permit a final statement to be made concerning the relative performance of the radial-stay boiler and the Jacobs-Shupert boiler. It appears, however, that the absorption of heat by the Jacobs-Shupert firebox is somewhat in excess of that absorbed by the radial-stay firebox, and that taking the boilers as a whole, the Jacobs-Shupert boiler is slightly more efficient.

Tests with Coal.—"The oil-fired tests already described have been duplicated by a series of coal-fired tests. The results obtained, so far as they refer to the distribution of work between the firebox and the tubes, and to the relative performance of the radial-stay boiler and the Jacobs-Shupert boiler, are in entire agreement with those obtained from oil."

The tests for strength under low water conditions in which each boiler will be subjected to a progressive series of tests until the destruction or serious deformation of the firebox occurs, will take place at Coatesville, Pa., on June 20, 1912.

GLASS ENGINE NUMBERS

The gas in tunnels on the Northern Pacific is so corrosive that it soon destroys the painted numbers on locomotives and way cars, and on the Mountain division it is necessary to protect these numbers with glass. The illustration shows the method devised by A. M. Burt, superintendent of the division for doing this. On engine cabs the numbers are left as painted, and over them is bolted a wooden frame of 1⅛ in. x 1¾ in. material of the proper length to take the required number of double

Locomotive Provided with Glass Numbers.

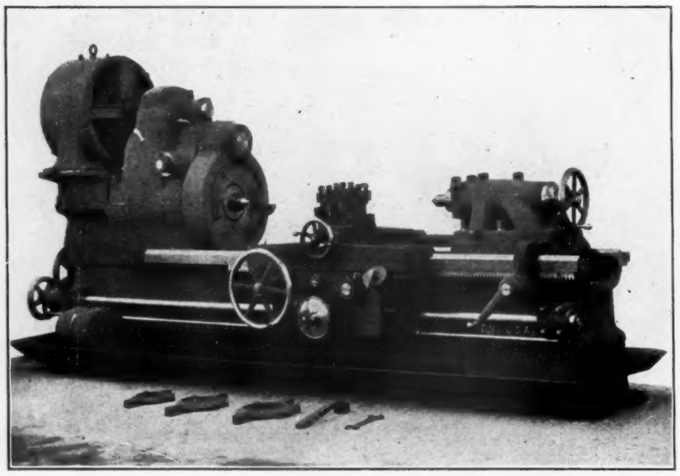
strength panes of glass, one pane for each number. The numbers are painted in white on the back of the glass, the balance being painted black. The glass is fastened to the frame by quarter round beading. The object of leaving the old numbers on the cab is to retain the complete engine number in case the glass becomes broken, although this seldom occurs. The service of these glass numbers is practically unlimited and the numbers are very easily kept clean and legible. The way cars on the Mountain division have the numbers treated in a similar manner.

A LONG SPAR.—A spar shipped recently from Sheldon, Mason county, Washington, on the Peninsular Railroad, measured 102 ft. in length and was carried on two 41-ft. platform cars, with another car of the same length between them. The spar was 6 ft. 6 in. in diameter at the butt and 3 ft. 6 in. at the smaller end, and it scaled 9,000 ft. of lumber.

HEAVY DUTY LATHE

A powerful lathe designed for turning heavy forgings and well suited for shops that forge their own driving axles and piston rods, has been designed by the Lodge and Shipley Machine Tool Company, Cincinnati, Ohio. It has clearance for a 15 in. diameter over the tool post and will swing 30½ in. diameter over the bed. As shown in the illustration, it is fitted with a 30 h. p. direct current variable speed motor having a speed ratio of from 400 to 1,200 r. p. m. There are also two gear changes which, in connection with the motor, will give spindle speeds from 15.6 to 173 r. p. m. This gives a minimum cutting speed on a 15 in. diameter of 61 ft. per min., and a maximum on a 3 in. diameter of 136 ft. per min.

Very heavy parts and bearings of liberal area characterize the design of the head-stock and apron. All driving gears are of steel, hardened and heat treated. The lightest gear in the head has a 4 diametrical pitch. The front bearing of the spindle has a projected area of 60 sq. in., and the back bearing an area of 47 sq. in. The spindle is solid and runs against a hardened steel plug at its back end to take up the thrust. On the driving shaft are bearings on both sides of the gears in all cases and an oil circulation is provided for all driving gears and journals, as well as for the thrust bearing. The oil drains from the bearings to a reservoir cast in the bed and is pumped from there by a spiral geared pump to a reservoir at the top of the head, from which it flows by gravity to the various bearings. The machine will deliver, with a 30 horse-power motor, up to 19,500 lbs. pressure at an 8 in. diameter and 25,000 lbs. under the same conditions when the motor carries a 30 per cent. overload. This would ordinarily create a pressure of over 300 lbs. per sq. in. on the spindle bearing, but in this case the driving pinion is so placed that the pressure of the cut is opposed by it and the amount of pressure on the bearings is greatly reduced.



Powerful Lodge & Shipley Lathe for Forgings.

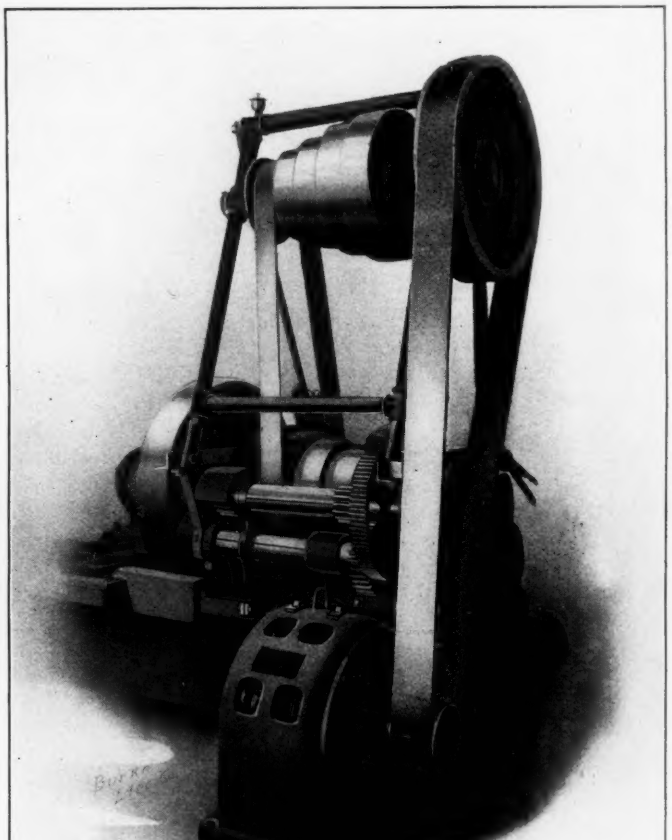
The rack pinion in the apron is of high carbon steel, is unusually large in diameter and has a wide face. In fact the smallest face of any gear in the apron is 1½ in., and the smallest gear is 3½ in. in diameter. The smallest diametral pitch is 5. The steel bevel gear on the feed rod has two keys diametrically opposed to each other. The feed rod is driven by a plain change gear and four changes of feed are provided. The motor control rod extends along the front of the bed and is operated by a handle near the top of the carriage.

In size, length of bearing and rigidity, the carriage is in keeping with the rest of the machine. It has 245 sq. in. total bearing area on the bed, and is gibbed front and rear, as well as under the inside V's. The tool block is steel and rests on a cast iron cross slide. It has one center slot to accommodate tools 1¼ in. x 2½ in., and two open sides for tools of the same dimensions. The cross slide has 168 sq. in. bearing surface on top of the carriage and the feed screw is placed as high as possible to resist the action of the cut. An oil trough is cast around the carriage, so arranged that the lubricant from the cutting tool will not flow to the sliding surfaces. This drains from its four corners into the drip pan under the bed. A substantial pump is provided, geared to the head-stock, which will deliver a ¾ in. stream of lubricant to the cutting tool at the rate of sixteen gallons per minute. A telescopic tubing, with proper stuffing boxes to take care of the longitudinal traverse of the carriage, is used instead of the usual flexible tubing.

The large steel oil pan under the bed is placed only far enough from the floor to permit a cast iron drip pan mounted on rollers to be run under it. The lubricant from the oil pan drains directly to this drip pan and is pumped from it to the cutting tool. The shipping weight of this machine with a 12 ft. bed, complete with 30 h. p. motor, is approximately 20,000 lbs.

MACHINE TOOL MOTOR APPLICATIONS

It is frequently desirable to apply an electric motor to a machine tool which is designed for, and has been operated, by a belt drive. For example: it is sometimes found necessary to operate the shafting for a whole group of machines a large proportion of the time in order to drive a single tool in the group, in which case it might be advisable to provide the tool with an individual drive. Again, the constant improvements being made in the various shops often make it necessary or advisable to so locate a machine as to make it inconvenient, or impossible, to drive it from shafting.

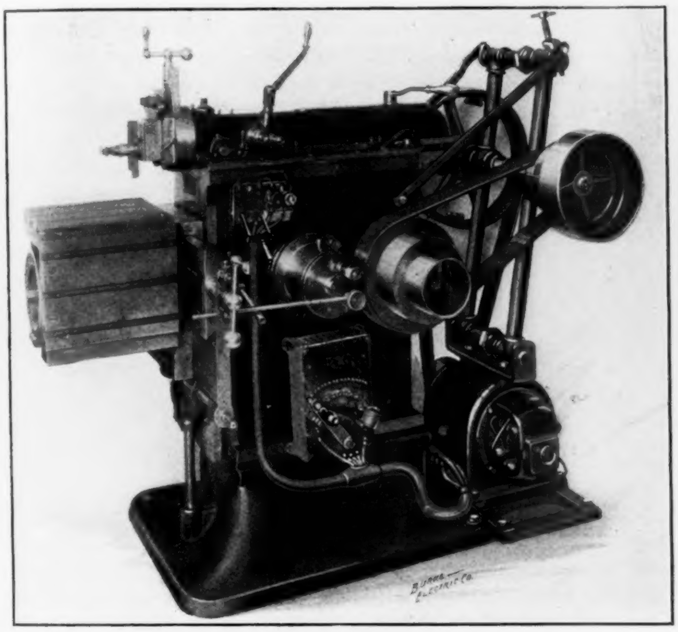


Motor Applied to a Belt Driven Lathe.

For use in such cases, the Burke Electric Company, Erie, Pa.,

is furnishing a framework and motor support which permits the direct application of a motor to the tools, allowing them to be operated in the same manner as if they were belted directly to the countershaft. If a variable speed motor can be applied, this arrangement also permits a decided increase in the range of speed changes on the tool.

In the accompanying illustrations are shown applications made by this company to a large lathe and to a shaper. It will be seen that the cone pulleys are retained. The motors are so located as to take up very little, if any, extra room and drive through belts to the pulleys on the countershaft, which gives the necessary



Burke Speed Changing Device Applied to a Shaper.

speed reduction. The shafts carrying the pulleys and the cones are carried by frames largely made up of pipe fittings, which are secured to the bed of the machine and so arranged as to permit a variation in the tension of the belts on the cones. This movement of the frame is obtained by a cam conveniently located, which can be locked at any point. In this way, a loose belt can be used for high speed operation and a tight belt for low speeds, and the shifting of the belt can be performed much easier and with less damage than if it was at a constant tension. It also permits the movement of the spindle or head by hand when setting work.

BORING WITH A RADIAL DRILL

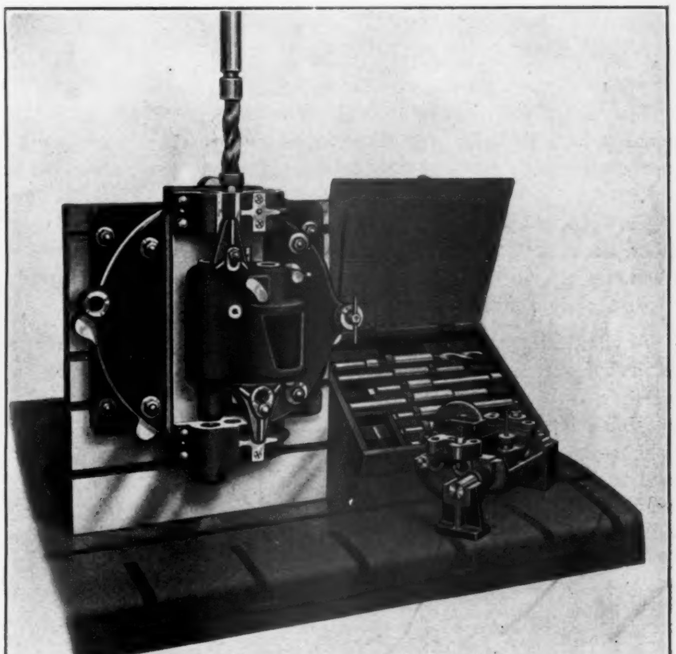
In the shops of the American Tool Works Company, Cincinnati, Ohio, are a number of horizontal boring machines which are required to perform many operations of the greatest accuracy in boring. In a machine tool builder's plant of this character, there is of course a constant effort to obtain the greatest efficiency consistent with high quality of output, and in the detail studies of various operations it has developed that for certain classes of work the radial drill is far superior to a horizontal boring machine in the matter of time, and produces results of an equally high character. The machine used is a 6 ft. American radial drill of standard design.

As an illustration of the improvement obtained by the change, the work on the quick change gear box for a 16 in. lathe may be cited. When these boxes were bored on a horizontal boring machine it required 216 hours to finish 36 pieces. On the drill, by means of a suitable jig, the time is reduced to 45 hours for 36 pieces, a saving of 171 hours. Similarly, the work on the aprons for 24 in. high duty lathes required 72 hours for a lot of 12 pieces in the horizontal boring machine, while the drill was able to do the work equally well in 24 hours, a saving of 48 hours.

Boring a Lathe Apron on a Radial Drill.

The arrangement of the jigs for this operation is also shown in one of the illustrations.

It is appreciated, of course, that an equal saving would not be general and that there are many operations which can be satis-



Boring a Speed Change Box on a Radial Drill.

factorily handled only on the horizontal boring machine. The instances given, however, illustrate typical examples which clearly indicate that there are some classes of work now being generally performed on boring machines for which a radial drill of suitable design and power is much better suited.

WIRELESS TELEPHONE.—Telephone conversation by means of wireless apparatus was, on May 17, transmitted a distance of over 160 miles, from Monte Marie, Italy, to Magdalena Island.

General News Section

The University of Illinois announces that contracts will be let shortly for the new transportation building and the new locomotive testing laboratory.

Governor Foss, of Massachusetts, has signed a bill increasing the penalty from $5,000 to $10,000 to be imposed on a railway for the loss of life of an employee because of negligence.

The Chicago, Burlington & Quincy was fined $300 in the federal court at Kansas City on May 3 for violation of the safety appliance law in running a train in its yards with less than 75 per cent. of the air brakes coupled.

The Brotherhood of Locomotive Engineers, in biennial session at Harrisburg, Pa., has voted that hereafter the convention shall be held only once in three years. Warren S. Stone was re-elected grand chief for a term of six years, by a large majority. The following were also elected: Assistant grand engineers, L. L. Griffing, Long Island, N. Y.; F. A. Burgess, Louisville; Ash Kennedy, Winnipeg.

The Massachusetts legislature has rejected the bill recommended by Governor Foss to provide for the merger of the Boston & Maine with the New Haven, and for the electrification and other improvements at Boston, the Senate rejecting it by a vote of 15 to 20. Governor Foss has told his friends that he will call an extra session of the legislature in July for the purpose of passing the bill.

Operation on the Rock Island lines on Friday, May 10, was affected by a variety of weather conditions. There was a snow storm near Calhan, Colo., and a dust storm driven by a 30-mile an hour wind at Gem, Kan., which piled sand so high in several cuts that it was necessary to send for a gang of workmen to clear the track. At about the same time there was a washout at Smith Center on the Nebraska division that cost the company $6,000.

The anthracite coal miners in convention at Wilkesbarre last week adopted the report of their committee recommending an agreement with the operators. The plan, as presented by the operators, provides for fixed rates of wages, and the sliding scale, which has been in force during the past ten years, is abolished; but it is said that the new rates are enough higher than the old, so that the miners will be decidedly better off than with the sliding scale.

A committee of officers of the Harriman Lines is making a study of the safety committees which have been organized on various railways with the idea possibly of recommending the establishment of similar organizations on the Harriman Lines. The committee is composed of W. R. Scott, assistant general manager, Southern Pacific; M. J. Buckley, assistant general manager, Oregon-Washington Railroad and Navigation Company, and Charles Ware, assistant general manager, Union Pacific.

The Chicago Great Western has announced a "get-together" meeting to be held under the auspices of the enginehousemen, shopmen, track and bridgemen at Oelwein, Iowa, on June 8. Employees of other departments are invited, and any officers who may be present will be expected to take back seats and consider themselves, for the evening, as employees, and not as officials. Mrs. H. J. Slifer, wife of the general manager, will give a lecture on "A Trip Across the Isthmus of Panama," illustrated by about 200 stereopticon pictures.

The California Industrial Accident Board, in its first decision, holds that Harry Christ, an employee of the Pacific Telephone and Telegraph Company, who lost an eye while at work, is entitled to receive $100 for medical and surgical expenses, full wages for time in hospital, 65 per cent. of his wages for the following eight weeks, and 65 per cent. of his estimated loss in earning capacity thereafter for a maximum period of 15 years. The board finds that although the loss of an eye does not necessarily impair a man's earning capacity, it increases the difficulty of finding work.

The Chicago Association of Commerce Committee on Smoke Abatement and Electrification of Railway Terminals has 20 observers at work recording observations of 1,000 smoke stacks typical of the various plants consuming coal in Chicago. Observations at intervals of one minute for periods of a complete day will be taken by the observers who will record the classification of smoke as to density according to the Ringelmann chart and the exact percentage of density will be determined for each stack. Later a similar investigation is to be made of the locomotive smoke on each railway line of the city.

It is announced that the Southern Pacific is to follow the plan of giving publicity to accidents which has been in effect on the Union Pacific and other lines of the Harriman system for several years. Following an accident that is not of minor consequence the ranking officer of the division will convene a board composed of two disinterested persons not connected with the railway, and the division officers representing the operating, mechanical and engineering departments. The board will conduct a thorough investigation to fix the responsibility for the accident, and its findings will be given to the newspapers.

An International Safety Congress will be held in Milan, Italy, May 27-31. This congress, the first of its kind of international scope ever held, will be for the purpose of promoting a world wide movement for the conservation of human life in industry. The American Museum of Safety, New York, is making preparations to have the United States well represented. An American national committee has been selected by the museum to co-operate with the international body and to promote the American ideas and views at the congress. Dr. W. H. Tolman, director of the American Museum of Safety, James McCrea, president of the Pennsylvania, and other members of the committee will attend the congress. Among the papers which will be read at the congress are: The Safety Engineer on a Large Transportation System, by Dr. W. H. Tolman, and The Work of the Safety Committee of the United States Steel Corporation.

About 250 pensioned employees of the Southern Pacific attended the annual banquet at the Palace Hotel, San Francisco, on May 10. The banquet this year fell upon the forty-third anniversary of the driving of the last spike of the first trans continental railway in the United States, at Promontory, Utah. Approximately half of those now on the pension roll were factors in the construction of the system at that time, and it is the annual custom for the road to be built in reminiscence. Part of the entertainment was the exhibition of a complete set of 250 photographs taken during the construction period of the Central Pacific, and several of the higher officers of the road addressed the gathering. Since the inauguration of the pension system on the Southern Pacific, January 1, 1903, $1,015,014 has been paid out in pensions. The system is absolutely voluntary on the part of the company, and 718 former employees have been awarded pensions in these nine years. On May 1 this year there were 477 pensioners on the rolls.

On May 27 the Supreme Court for the District of Columbia entered a final decree dissolving the injunction and dismissing the suit in the case that Peter H. Murphy brought against the Baltimore & Ohio for infringement of his car roof patents. The roofs were furnished by the Chicago-Cleveland Car Roofing Company, which protected the Baltimore & Ohio in defending the suit. This final decree was in accordance with the decision

of the Court of Appeals for the District of Columbia, which, on April 22 last, entirely reversed the previous decree of the lower court. The previous decree had held that the patents were valid and infringed upon, but the Court of Appeals wholly reversed it, and also, on May 14, denied Mr. Murphy's petition for a rehearing. On May 17 the Court of Appeals also overruled Mr. Murphy's opposition to granting the Baltimore & Ohio a large item of recoverable costs of the suit. There was also on April 29 a ruling of the Supreme Court of the United States that precluded any further appeal in such a suit. The Baltimore & Ohio was thus entirely sustained in the matter.

As a reward for faithful service the Missouri Pacific-Iron Mountain system has decided to issue annual passes to employees who have worked for the company 15 years or longer. The rules provide that for 15 years of continuous service an employee may receive an annual pass for himself over the division on which he is employed; for 20 years' continuous service, one for himself and wife over the division, and for 25 years' continuous service one for himself and wife over the entire Missouri Pacific-Iron Mountain system of nearly 7,300 miles. About 1,500 employees will receive these passes, including agents, conductors, enginemen, brakemen, train baggagemen, switchmen, firemen, hostlers, telegraphers, bridge and building foremen and section foremen. R. W. Waters, a conductor on a suburban train running out of St. Louis, now in his 52d year of continuous employment, is the oldest man in point of service on the entire system. John Cook, and his son, C. W. Cook, both employed on the Central Kansas division as passenger enginemen, under the 25 years of service ruling, are entitled to annual passes for themselves and wives.

The employees' compensation bill has passed the Senate at Washington by a vote of 64 to 15, but not until it had been vehemently opposed by a few senators. This bill was prepared with much care by a special commission and was recommended to Congress by President Taft. It provides that accidental disability or death of employees shall be subject to compensation, to be paid by the employer, and applies to all persons employed by railways engaged in interstate commerce. Numerous changes were proposed by senators, but the opposition was strong, and only a few amendments were accepted. One of the changes modifies the period during which children shall receive compensation; the age of 16, the ordinary limit, is to be extended, in the case of a daughter, to the age of 20, unless she marries before that age. The opposition to the bill seems to be based mainly on the claim that injustice will be done to railway employees who suffer serious injuries by fault of the employer and who, under present laws, may sue for heavy damages—much heavier than would be allowed under the proposed law. One of the objecting senators said that the officers of the labor unions, in endorsing the bill, have not fairly represented their constituents; but, on the other hand, some of the observers at Washington say that the opposition has come mainly from senators who, under the present law, make a good deal of money out of their work in prosecuting suits against the railways.

The Educational Bureau of the Union Pacific has issued a new instruction pamphlet, entitled "Safety First," containing several pages of "don'ts" for employees of the operating department, the observance of which would greatly reduce the number of accidents. Preceding the list of "don'ts" are several paragraphs devoted to observation of rules; the company expects employees to live up to the rules absolutely, and in all cases of doubt or uncertainty the safe course must be taken and no risks run. Some of the comments are as follows: "It is a common saying among railway men that if one lived up to the book of rules to the letter, he would never get over the road. This is true only in a degree, because the man who seems slow often accomplishes more, and as a rule works longer without causing accidents or injuries and does less damage to property than the man who is always in a hurry and never does things exactly right. The company *does* want its rules lived up to. If there are rules that are found impracticable they can be changed and modified by a bulletin or special order, thus safeguarding all and hindering no one. The man who takes chances may be praised by a thoughtless official as long as he doesn't get into trouble, but the man who praised him while he kept out of trouble is the same man who will quickest discharge him when he takes the one chance too many or takes it too often. Employees are asked to make suggestions for additional "don'ts" or for photographs or moving pictures that could be taken to illustrate the right and wrong way of doing things, or to show more clearly what things not to do to avoid accidents.

FREIGHT RATE ON MATERIAL FOR REPAIRS OF CARS DAMAGED ON FOREIGN LINES.

Joseph W. Taylor, secretary of the Master Car Builders' Association, has issued to members the following circular concerning a proposed change in the M. C. B. rules:

Conference Ruling No. 333, of the Interstate Commerce Commission, reads as follows:

"333. Company Material.—Material for use in the repair of one of its cars was shipped by a carrier to the shop of a connecting line. Upon inquiry whether the material could move free of charge over both roads, it was held, That in cases of this kind company material may move without charge only over the line at whose expense the repair is made."

Inasmuch as present Rule 122 conflicts with this conference ruling, the Arbitration Committee suggests, and it will so recommend to the convention in June, that the first paragraph of Rule 122 be changed to read as follows:

"Rule 122. Companies shall promptly furnish to each other, upon requisition, and forward, freight charges from point of shipment to destination to follow, materials for repairs of their cars damaged upon foreign lines, excepting that the company having car in its possession at the time shall provide from its stock the following:

"Lumber, forgings, hardware stock, paint, hairfelt, piping, airbrake material and all M. C. B. standard material.

"Requisitions for such material shall specify that same is for repairs of cars, giving car number and initial of such car, together with pattern number or other data, to enable correct filing of requisition."

Under the ruling of the commission, material for repairs of foreign cars may be moved without charge over the line at whose expense the repairs are made, but the committee believes that less trouble and annoyance will be occasioned if the shipment is made on a freight rate from point of shipment to destination.

MEETINGS AND CONVENTIONS

Canadian Northern Club.—This is the name of a club which has been organized at Toronto by officers and employees of the Canadian Northern, the purpose being to promote both knowledge of railroading and better personal acquaintance and friendship. Meetings are to be held on the first Tuesday of each month. The president is A. J. Hills; secretary, R. Croasdell.

Western Railway Club.—The annual meeting of the Western Railway Club was held in the Karpen building, Chicago, on Tuesday evening, May 21. The membership of the club is now 1,437. The following were elected officers for the ensuing year: President, T. H. Goodnow, general superintendent, Armour Car Lines; first vice-president, H. H. LaRue, master car builder, Chicago, Rock Island & Pacific; second vice-president, W. B. Fall, superintendent, Mather Stock Car Company; secretary and treasurer, J. W. Taylor. The members were entertained with a musical program at the close of the meeting.

International Association for Testing Materials.—The sixth annual congress of the International Association for Testing Materials will be held in New York, September 2 to 7, 1912. Every effort will be made to accommodate the foreign delegates to this congress and the proceedings will be conducted in English, German and French, with the aid of competent interpreters. Several excursions have been arranged for, so that the visiting delegates will have a chance to visit places of interest in the eastern section of this country, special arrangements being made for those desiring to go as far west as the Illinois Steel Company's plant at Gary, Ind. Over 150 reports and papers will be presented during the convention.

National Association of Manufacturers.—The annual convention of the National Association of Manufacturers was recently held in New York City, with John Kirby, Jr., of Dayton, Ohio, president of the association, in the chair. In his opening remarks Mr. Kirby declared that the past year has witnessed the steady decline of labor unionism of the "Gompers type." The committee on interstate commerce and Federal incorporation in its report defends the Commerce Court. Although the court has not in all instances acted in perfect harmony with the Interstate Commerce Commission, it is not fair to assume that the court merits the criticism directed against it. The proposals for Federal incorporation laws have made little progress during the past year, and the manufacturers are urged to work for them in the interest of a sane regulation of industry. The prime function of our government should be to promote an attitude of sympathy and co-operation. W. J. H. Boetcker made an urgent plea for a strenuous campaign to further knowledge and skill in the various trades of our boys and girls. "Workers must be taught that we are not their natural opponents because we are their employers, but that there is a mutuality of interest that binds more strongly than the differences which may from time to time arise, and which are sometimes unavoidable. Motion pictures were given showing the cause, effect and remedy of various kinds of industrial accidents, a model factory fire drill and a lifeboat drill at sea. More than 1,000 employers and delegations of workmen attended this exhibition. Frank E. Law, vice-president of the Fidelity & Casualty Company, New York, gave an address on "Workmen's Compensation for Accidents."

The following list gives names of secretaries, dates of next or regular meetings, and places of meeting of mechanical associations.

AIR BRAKE ASSOCIATION.—F. M. Nellis, 53 State St., Boston, Mass. 1913 convention to be held at St. Louis, Mo.

AMERICAN RAILWAY MASTER MECHANICS' ASSOC.—J. W. Taylor, Old Colony building, Chicago. Convention, June 17-19, Atlantic City, N. J.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—M. H. Bray, N. Y., N. H. & H., New Haven, Conn. Convention, July 9, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. 39th St., New York.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 North 50th Court, Chicago; 2d Monday in month, Chicago.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—D. B. Sebastian, La Salle St. Station, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—L. H. Bryan, Brown Marx building, Birmingham, Ala. Convention at Chicago, July 23-26, 1912.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, Lima, Ohio. Convention, August 15, Chicago.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Old Colony building, Chicago. Convention, June 12-14, Atlantic City, N. J.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOC. OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass. Convention, September 10-13, Denver, Col.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. & H. R., East Buffalo, N. Y. Convention, August 27-30, Sherman Hotel, Chicago.

PERSONALS

GENERAL.

C. HOUSTON has been appointed master mechanic of the Nacozari Railroad, with office at Nacozari, Senora, Mex.

F. HONAKER, master mechanic of the St. Louis & San Francisco at Birmingham, Ala., has been transferred to Fort Scott, Kan.

H. W. CODDINGTON has been appointed engineer of tests of both the locomotive and car department of the Norfolk & Western.

F. T. PERRIS has been appointed manager of the fuel department of the Atchison, Topeka & Santa Fe Coast Lines, with office at Olinda, Cal.

F. C. RIPLEY has been appointed assistant manager of the fuel department of the Atchison, Topeka & Santa Fe Coast Lines, with office at Midoil, Cal.

B. A. BELAND, master mechanic of the St. Louis & San Francisco at Fort Scott, Kan., has been transferred to Birmingham, Ala., succeeding H. Honaker.

J. M. CHAFFEE has been appointed road foreman of engines on the Mohawk division of the New York Central & Hudson River, vice C. W. Stark, promoted.

E. R. WEBB, division master mechanic of the Michigan Central, at Michigan City, Ind., has been transferred to St. Thomas, Ont., succeeding Mr. Flynn, promoted.

T. J. BURNS, assistant to the superintendent of motive power of the Michigan Central, at Detroit, Mich., has been appointed assistant superintendent of motive power.

F. W. THOMAS has been appointed supervisor of apprentices of the Atchison, Topeka & Santa Fe, and the Atchison, Topeka & Santa Fe Coast Lines, with office at Topeka, Kan.

A. P. PRENDERGAST, superintendent of motive power of the Baltimore & Ohio Southwestern at Cincinnati, Ohio, has had his jurisdiction extended over the Cincinnati, Hamilton & Dayton.

J. A. HALEY has been appointed master mechanic of the Bellingham Bay & British Columbia, with office at Bellingham, Wash., succeeding M. Dailey, resigned to accept service with another company.

R. S. MOUNCE, assistant to the general foreman of the Erie at Cleveland, Ohio, has been transferred to the personal staff of William Schlafge, general mechanical superintendent at New York City.

F. W. TAYLOR, master mechanic of the Illinois Central at Mattoon, Ill., has been appointed master mechanic, with office at Waterloo, Iowa, in place of J. A. Bell, who succeeds Mr. Taylor at Mattoon.

E. D. BRONNER, who has been superintendent of motive power of the Michigan Central for the past 20 years, with office at Detroit, Mich., has been appointed general manager, vice R. H. L'Hommedieu.

W. H. CORBETT, road foreman of engines of the Michigan Central, at Jackson, Mich., has been promoted to the position of division master mechanic, at Michigan City, Ind., succeeding Mr. Webb, transferred.

C. W. STARK has been appointed supervisor of mechanical instructions and examination of enginemen for the eastern district of the New York Central & Hudson River, vice D. Cassin, assigned to other duties.

A. O. GARBER, general foreman of the Illinois Central at Paducah, Ky., has been appointed master mechanic, with office at

East St. Louis, Ill., succeeding W. H. Donley, given a leave of absence on account of illness.

WALTER H. FLYNN, division master mechanic of the Michigan Central at St. Thomas, Ont., has been appointed superintendent of motive power, with office at Detroit, Mich., succeeding E. D. Bronner, promoted to general manager.

S. F. HANCHOTT has been appointed road foreman of equipment on the Dakota division of the Rock Island Lines in connection with his other duties. His headquarters are located at Estherville, Iowa, and he succeeds F. Hopper, transferred.

H. H. HALE, formerly superintendent of the motive power and car department of the Cincinnati, Hamilton & Dayton at Cincinnati, has been appointed superintendent of the car department of that road and of the Baltimore & Ohio Southwestern.

M. J. DRURY, mechanical superintendent of the Northern district of the western lines of the Atchison, Topeka & Santa Fe, at La Junta, Colo., has been appointed superintendent of shops, with office at Topeka, Kan., succeeding John Purcell, promoted.

John Purcell has been appointed assistant to the vice-president in charge of operation of the Atchison, Topeka & Santa Fe system, with office at Chicago. Mr. Purcell began railway work in 1884 as an apprentice on the Santa Fe, and he has been with that road ever since. He was made gang foreman in 1887, and then filled various positions until he was appointed master mechanic at Argentine, Kan., about 1898 or 1899. He was later transferred as master mechanic to Shopton, Iowa, and in April, 1902, was promoted to superintendent of the Topeka shops, which office he held at the time of his recent promotion. In his present position Mr. Purcell will handle all mechanical department matters.


John Purcell.

F. HOPPER has been appointed road foreman of equipment of the Minnesota division of the Rock Island Lines, with office at Cedar Rapids, Iowa, vice C. F. Kilgore, assigned to other duties. Mr. Hopper will also cover the line between Vinton, Iowa, and Estherville.

W. I. ROWLAND, master mechanic of the Baltimore & Ohio at Grafton, W. Va., has been appointed assistant road foreman of engines of the Baltimore division, in charge of the engines of the Baltimore and Washington terminals, with headquarters at Baltimore, Md.

M. C. M. HATCH, formerly engineer of tests of the New York, New Haven & Hartford and the Boston & Maine, has been appointed superintendent of fuel service on the Delaware, Lackawanna & Western, with office at Scranton, Pa., and will have jurisdiction over all matters pertaining to fuel and fuel economies.

E. A. GILBERT, formerly western representative of W. H. Miner at Chicago, has been appointed general inspector of the motive power department of the Southern Pacific at San Francisco, Cal. He will have charge of all matters pertaining to rolling stock and shop practice.

JOHN HAIR, formerly superintendent of motive power of the Baltimore & Ohio Southwestern, at Cincinnati, Ohio, has been appointed safety inspector, and a member of the General Safety Committee, representing the mechanical department of the Baltimore & Ohio, with headquarters at Baltimore, Md., succeeding W. L. Robinson, promoted.

NELS OSGARD, whose appointment as master mechanic of the Great Northern, with office at Superior, Wis., was noted in the April issue of the *American Engineer,* was born May 26, 1869, in Norway. He received a common school education and began railway work with the St. Paul, Minneapolis & Manitoba, now the Great Northern, in October, 1887, at Minneapolis, Minn. He first worked in the engine house, taking care of ashpans and as engine wiper, and he was subsequently call boy, boiler washer, boilermaker, machinist, blacksmith and fireman. He became an engineer in November, 1896; in April, 1906, was promoted to traveling engineer, and except for about a year when he was road engineer again, he was a traveling engineer continuously until his present appointment. He was appointed traveling engineer of the Lake district in March, 1909, over which district he now has jurisdiction as master mechanic.

CAR DEPARTMENT

J. J. BURCH has been appointed division car inspector of the Norfolk & Western, vice J. R. Hayward, resigned.

SHOP

J. P. KELLY has been appointed acting locomotive foreman of the Canadian Pacific at Field, B. C.

W. J. RENIX, shop foreman of the Canadian Pacific at Brandon, Man., has been transferred to Moose Jaw, Sask.

B. E. SHONE has been appointed general foreman of the Depew, N. Y., shops of the New York Central & Hudson River.

T. S. BERTRAM has been appointed night foreman of the Canadian Pacific at Moose Jaw, Sask., having been transferred from Kenora, Ont.

R. MCPHERSON, shop foreman of the Canadian Pacific at Kenora, Ont., has been transferred to Brandon, Man., vice W. J. Renix, transferred.

A. PENTLAND, night foreman of the Canadian Pacific at Swift Current, Sask., has been transferred to Moose Jaw, Sask., vice T. S. Bertram, transferred.

W. C. MAYO, night locomotive foreman of the Canadian Pacific, at West Toronto, Ont., has been appointed locomotive foreman at Port McNicoll, Ont.

J. G. PARSONS has been appointed superintendent of shops of the New York Central & Hudson River, at Depew, N. Y., succeeding H. Wanamaker, transferred.

H. WANAMAKER, superintendent of shops of the New York Central & Hudson River, at Depew, N. Y., has been appointed superintendent of shops at West Albany, N. Y., succeeding L. H. Raymond, resigned.

W. J. HOSKIN, who recently resigned as master mechanic of the Chicago & Alton at Bloomington, Ill., has been appointed assistant master mechanic of the Paducah shops of the Illinois Central, with headquarters at Paducah, Ky.

OBITUARY

N. M. MAINE, general master mechanic of the Chicago, Milwaukee & Puget Sound, with office at Tacoma, Wash., died at Tacoma, on May 10.

NEW SHOPS

BALTIMORE & OHIO SOUTHWESTERN.—The contract has been awarded for the erection of two additions to the machine shop at Washington, Ind., to cost $35,000, and improvements to the engine house which will cost $25,000.

CANADIAN NORTHERN.—Repair shops and an engine house will be built at Port Mann, B. C., the Pacific terminus of this road. The cost of the construction and equipment is fixed at $500,000.

CANADIAN PACIFIC.—A contract for the erection of new shops near Calgary, Alberta, which will cost about $2,500,000, has been awarded to Westinghouse, Church, Kerr & Company, New York. A main locomotive shop, 305 ft. x 312 ft., will be built, and will include the erecting, machine, blacksmith and boiler shops. The coach repair and paint shop will be 146 ft. x 360 ft., and the planing mill will be 80 ft. x 300 ft. The pattern shop will be 30 ft. x 100 ft., and the freight car repair shop 230 ft. x 300 ft. The foundry building will be 80 ft. x 204 ft. Numerous other buildings and structures, including a store room, office building, oil house, etc., will be built. The erecting shop will be of the transverse type and will contain 35 bays. The general construction of the building will be of concrete, steel, brick, or hollow tile, depending upon conditions. J. G. Sullivan, chief engineer of the western lines of the Canadian Pacific, is in charge of the work.

CHICAGO, MILWAUKEE & ST. PAUL.—A new engine house and machine shop will be built at Perry, Iowa. A 30-stall engine house, a 90-ft. turntable and a mechanical coaling station will be built at a point between Manheim, Ill., and Bensonville, about 15 miles from Chicago.

CINCINNATI, HAMILTON & DAYTON.—New locomotive shops will be built at Elmwood Place, Cincinnati, Ohio.

COLORADO & SOUTHERN.—Plans are being made for the construction of an engine house and shops at Hartville, Wyo.

EL PASO & SOUTHWESTERN.—Bids for an engine house, station and freight house, to be built at Tucson, Ariz., are asked for not later than June 20.

ILLINOIS TERMINAL RAILROAD.—The car shops which were destroyed by fire on May 3 at Alton, Ill., will be rebuilt and reequipped.

LOUISVILLE & NASHVILLE.—A large pumping station will be built at DeCoursey, Ky.

MICHIGAN CENTRAL.—A new engine house and shop buildings will be erected at Detroit, Mich.

NORFOLK & WESTERN.—Contracts have been awarded for the new shops at Columbus, Ohio. The buildings will be of brick and steel construction, and will include a 25-stall engine house; a 52 ft. x 139 ft. machine shop, with an annex of 35 ft. x 64 ft., for store and office buildings.

PENNSYLVANIA.—A new engine house, costing $200,000, will be erected at Indianapolis, Ind.

PERE MARQUETTE.—Receivers Walters and Blair have made application in the Federal Court at Detroit, Michigan, for permission to issue $2,000,000 receivers' certificates to build new stations, engine houses, coaling plants and extensions of the yards at Toledo, Ohio, and Port Huron, Mich.

SAN ANTONIO, ROCKPORT & MEXICAN.—Land has been acquired at Lockport, Tex., for an engine house, car shops and other terminal facilities. This road was incorporated last September, and will build from San Antonio, Tex., through Crowther and Rockport to Harbor Island. The work will later be extended to Tampico, Mex., and the City of Mexico.

WESTERN MARYLAND.—The erection of a new engine house and shops at Millersville, Md., has been started.

SUPPLY TRADE NOTES

The Union Draft Gear Company, Chicago, has moved its main offices to 1162 McCormick building.

The Adams & Westlake Company, Chicago, has moved its Philadelphia office to 2218 Ontario street.

The Automatic Ventilator Company, New York, has moved its main offices from 120 Liberty street to 2 Rector street.

The Ashton Valve Company, Boston, Mass., has moved its Chicago office from 166 West Lake street to 174 North Market street.

It is reported that the Canadian Car & Foundry Company of Montreal, Can., will build a car plant costing $1,500,000 at Fort William, Ont.

A. E. Davis has been appointed general manager of the Davis Boring Tool Company, of St. Louis. This company manufactures expansion boring tools.

The Pyle-National Electric Headlight Company, Chicago, has moved its offices from the McCormick building to 1000 Karpen building, 900 South Michigan avenue.

Ferdinand Schlesinger, of Milwaukee, Wis., and associates have purchased a tract of 415 acres at Hammond, Ind., with the purpose of building a large steel plant.

The Sherwin-Williams Company, Chicago, has moved its office from the Steger building to the eleventh floor of the Peoples Gas building, Michigan avenue and Adams street.

The Roberts & Schaefer Company, Chicago, has moved its general offices from the Old Colony building to the McCormick building, Van Buren street and Michigan boulevard.

The Chicago-Cleveland Car Roofing Company has moved its New York office to room 368, 50 Church street. Arthur S. Lewis has been added to the staff as eastern representative.

Hildreth & Company, New York, consulting and inspecting engineers have moved their main office from the Whitehall building, New York, to the Mills building, 15 Broad street.

The plant of the American Steel Foundries at East St. Louis, Ill., began regular operation on June 1. This plant has large orders for car material and will run at almost full capacity.

William Sellers & Co., Inc., Philadelphia, Pa., have purchased 46 acres of land at Folsom, Pa., on the Baltimore & Ohio, as a site for plant extension. This property is located 10 miles from Philadelphia.

J. M. Monroe, foreman of locomotive repairs of the Southern Railway shops at Columbia, S. C., has resigned that position and has gone to the Hunt-Spiller Manufacturing Corporation, Boston, as a representative.

The Kennicott Company, Chicago Heights, Ill., is erecting as an addition to its car shops a brick building 70 ft. x 323 ft., and is installing two new electric traveling cranes, orders for which were recently placed.

J. E. Fries has been made Pacific coast engineer of the Crocker-Wheeler Company, Ampere, N. J., with office at San Francisco, Cal. This company on April 1 opened an office in the Title Insurance building, Los Angeles, Cal.

The Baldwin Locomotive Works, Philadelphia, Pa., is making rapid progress with the construction of the various additions to its plant at Eddystone, Pa. The new erecting shop, which will be one of the largest of its kind, is rapidly approaching completion, and various other important improvements are under way. The operating force of the company is being steadily increased.

F. D. Reemer, who has been assistant purchasing agent of the American Car & Foundry Company, New York, has been ap-

pointed purchasing agent of the Haskell & Barker Car Company, Michigan City, Ind., with office in that city.

Edward E. Wright has been appointed manager of the central sales district for the McKeen Motor Car Company, Omaha, Neb., and will have charge of the new office which has been established by the company in the Marquette building, Chicago.

W. S. Quigley, until recently vice-president and general manager of the Rockwell Furnace Company, New York, has resigned that position to become vice-president of the new Quigley Furnace & Foundry Company, 50 Church street, New York.

Howard K. Porter, a southern representative of the Lorain Steel Company, Philadelphia, Pa., has been made manager of the southern railway department of the U. S. Metal & Manufacturing Company, New York, with office in Candler building, Atlanta, Ga.

A. H. Ehrenhaft, previously connected with the Hanna Engineering Works, has joined the sales force of the Vulcan Engineering Sales Company, Chicago. Mr. Ehrenhaft's special field will be that of riveters, and he will be located in the Hudson-Terminal building, New York.

The Kip Brush Company, New York, has made Wood, Bowers & Company, St. Louis, Mo., its southern representative. The Kip company recently organized a special railway department under the charge of Harry M. Baxter, formerly in charge of production and sales for the Wolfe Brush Company.

J. F. MacEnulty, formerly general manager of the Western Steel Car & Foundry Company, has been appointed general sales manager of the Western Steel Car & Foundry Company and of the Pressed Steel Car Company, a newly created position, with office at New York. He was born in Pittsburgh, Pa., January 10, 1879, and in 1899 he entered the service of the Pressed Steel Car Company at Pittsburgh as inspector, and later became foreman of the truck and bolster department, chief inspector and engineer of construction. He was then transferred to New York as sales agent, and about six years ago went to Chicago as general superintendent of the Western Steel Car & Foundry Company. In 1909 he was made general manager, which position he now leaves to take charge of the sales department in New York.

J. F. MacEnulty.

At the recent annual meeting of the Cement Products Exhibition Company, Edward M. Hagar, president of the Universal Portland Cement Company, Chicago, was elected president. It was decided to hold the sixth annual Chicago cement show in the Coliseum, January 16-23, 1913, but to hold no shows in New York and Kansas City, Mo.

J. E. Buckingham has been appointed superintendent of motor and refrigerator equipment of Wells Fargo & Company with headquarters at New York City. He will have general supervision of the mechanical department with respect to the construction and maintenance of motor and garage equipment, and refrigerator and ventilator cars.

George Price, formerly with the Tidewater Building Company, will represent the Flintkote Manufacturing Company and J. A. & W. Bird & Company, Boston, Mass., in the New York district in their line of building specialties, which cover roofing, water proof sheathing, water proofing compounds, Rex wall board, cold water bands, Ripoline enamels, etc. The New York office is located at 66 Beaver street.

W. H. Winterrowd, who, as reported in the May issue of the *American Engineer,* has been appointed mechanical engineer of the Damascus Brake Beam Company, Cleveland, Ohio, was born April 2, 1884, at Hope, Ind. He received an elementary education in the public schools at Shelbyville, Ind., and was graduated from Purdue University in 1907. In 1905, during his university training, he served as a blacksmith helper on the Lake Erie & Western at Lima, Ohio, and in 1906 served as car and air brake repair man on the Pittsburgh, Cincinnati, Chicago & St. Louis at Dennison, Ohio. In the latter part of the same year he engaged in locomotive test work on the Big-Four at Indianapolis, Ind. On graduating Mr. Winterrowd entered the service of the Lake Shore & Michigan Southern as special apprentice, serving in that capacity until 1908, when he was made engine house foreman of the Lake Erie, Alliance & Wheeling, at Alliance, Ohio. In 1909 he was made night engine house foreman on the Lake Shore & Michigan Southern, at Youngstown, Ohio, and in 1910 was transferred to Cleveland, Ohio, in the same capacity. Later in the same year he was promoted to assistant to the mechanical engineer on the Lake Shore & Michigan Southern, which position he held until his recent appointment as mechanical engineer of the Damascus Brake Beam Company and Railway Supply Company, at Cleveland, Ohio.

William H. Winterrowd.

The court of appeals of the District of Columbia on April 22 rendered a decision in the suit of Peter H. Murphy against the Baltimore & Ohio for infringement of the Murphy outside metal car roofs patents in roofs furnished by the Chicago-Cleveland Car Roofing Company, reversing the decision of the Supreme Court of the District of Columbia rendered on November 27, 1911, which held that the patents had been infringed.

At the stockholders' meeting of the Kelly Reamer Company, Cleveland, Ohio, the following were elected directors of the company: William E. Kelly, W. A. Calhoon, H. J. Maxwell, O. H. P. Davis, E. B. Jessop, George Bauer and Thomas A. Torrance. The following officers were also elected: William E. Kelly, president and general manager; W. A. Calhoon, vice-president; H. J. Maxwell, secretary, and O. H. P. Davis, treasurer.

Charles J. Symington, general sales agent of the T. H. Symington Company, Baltimore, Md., with office at Chicago, has been made vice-president in charge of sales, with office in New York, and Thomas C. de Rosset, sales agent of the Symington company, has been made manager of eastern sales of that company, with headquarters in Baltimore, succeeding John F. Symington, resigned to go to Hambleton & Company, Baltimore, a banking firm.

James Rawle, president of the J. G. Brill Car Company, Philadelphia, Pa., died at his home at Bryn Mawr, May 1, at the age of 70. Mr. Rawle was graduated from the University of Pennsylvania in 1861 as a civil engineer. In 1872 he became a

partner with John G. Brill and George M. Brill in the manufacture of street railway cars. In 1887, when the firm was incorporated as the J. G. Brill Company, Mr. Rawle took charge of the finances.

The various steel companies of the Lake Superior Corporation, Sault Ste Marie, Ont., have been combined into the Algoma Steel Corporation, in accordance with its plans for the consolidation of the various subsidiary companies in natural groups. The companies to be included in the consolidation are the Algoma Steel Company, Sault Ste Marie; the Lake Superior Iron & Steel Company, Montreal, Que.; the Lake Superior Power Company; the Fiborn Limestone Company; the Cannelton Coal & Coke Company, and the Algoma Iron Works, Ltd.

The Vulcan Engineering Sales Company, Fisher building, Chicago, has been organized by the Hanna Engineering Works, Chicago, the Mumford Molding Machine Company, Plainfield, N. J., and the Q M S Company, Plainfield, N. J., for the purpose of handling the sales and distribution of the goods made by these companies. The same engineering organizations of the different companies will continue as before, only under the name of the Vulcan Engineering Sales Company. The principal officers are J. K. Gilbert, president, and Philetus W. Gates, secretary-treasurer. The New York office of this company is located in the Hudson-Terminal building.

The Southwark Foundry & Machine Company, Philadelphia, Pa., manufacturer of turbine engines, has been sold. The new board of directors consists of Alba B. Johnson, Samuel B. Vauclain, Holstein De Haven Bright, John P. Sykes, Reeves K. Johnson, Alba B. Johnson, Jr., Jacques L. Vauclain and Andrew C. Vauclain. The new officers are as follows: President, Holstein De Haven Bright; vice-president and treasurer, James H. Maloney, and secretary, Alfred C. Maule. Alba B. Johnson, president of the Baldwin Locomotive Works, Philadelphia, Pa., said that this was an individual enterprise and that the Southwark company would have no connection with the Baldwin Locomotive Works.

CATALOGS

Bearing Metal.—The Damascus Brass Company, Pittsburgh, Pa., has issued a 24-page pamphlet describing its various bearing metals.

Radial Drills.—The Fosdick Machine Tool Company, Cincinnati, Ohio, has issued a circular illustrating its 4-ft. and 5-ft. National radial drills.

Unions.—The National Tube Company has issued bulletin No. 9, which describes some tests made on the Kewanee unions. The sizes tested were from ½ in. to 2 in.

Ball Bearings.—The Hess Bright Mfg. Company, Philadelphia, Pa., has issued a 32-page pamphlet describing the application of ball bearings to woodworking machinery.

Anti-Friction Metal.—The Magnolia Metal Company, New York, has issued pamphlets in English, Spanish and Portuguese, giving full directions for the pouring of its anti-friction metal.

Heater Cars.—The Alcohol Heating & Lighting Company, Chicago, has issued an illustrated booklet, describing its combined alcohol heater and refrigerator cars for the handling of perishable freight.

Special I-Beams.—The Carnegie Steel Company, Pittsburgh, Pa., has published a 12-page booklet giving the physical properties of I-beam sections which are supplementary to the American standard sections.

Unions.—The National Tube Company, Pittsburgh, Pa., has devoted bulletin No. 9 to the results of tests of Kewanee unions. The bulletin also describes the construction of these unions and points out their advantages.

Nut Locks.—The Boss Nut Lock Company, Chicago, has issued a 16-page pamphlet describing the different types of boss nuts, explaining how these nuts lock and giving the general sizes and prices of the square and hexagon types.

Electric Hoists.—The General Electric Company, Schenectady, N. Y., has issued bulletin No. 4939, which describes the electric hoists manufactured by that company. This bulletin supersedes the previous bulletin on the same subject.

Pumps.—The Ingersoll-Rand Company, New York, has published bulletin No. 7004 on Cameron steam pumps, which is illustrated and describes in detail the construction and operation of these pumps. Prices and dimension tables are also included.

Grinding Wheels.—In the April issue of the bulletin called Grits and Grinds, issued by the Norton Grinding Company, Worcester, Mass., the question of balancing grinding wheels is discussed in detail. Both the running and standing balance is considered.

Test Meters.—The General Electric Company, Schenectady, N. Y., has published bulletin 4942 on Thomson direct current test meters, type C B-4. This bulletin is illustrated, gives detailed descriptions and supersede the company's previous bulletin on this subject.

Induction Motors.—The Crocker Wheeler Company, Ampere, N. J., has issued Bulletin No. 141, illustrating and describing certain interesting details in the construction of their form *R* induction type motor, designed for operating from 25 cycle, polyphase, a. c. circuits.

Grates.—The Shear-Klean Grate Company, Chicago, has published a small booklet on Shear-Klean grates, in which their many advantages are pointed out and in which their construction is briefly and concisely described. It is claimed that these grates save both coal and labor.

Electric Lamps.—The General Electric Company, Schenectady, N. Y., has issued bulletin No. 4947, describing the Edison-Mazda and Gem lamps for railway service. The bulletin contains illustrations showing cars lighted by these two types of lamps compared with the old carbon filament lamps.

Hydraulic Jacks.—Richard Dudgeon, New York, manufacturer of hydraulic jacks, has published a small illustrated booklet entitled The History of the Hydraulic Jack. It gives a brief history of the development of hydraulic jacks, a detailed description of their construction, and a number of points on their care and upkeep.

Pneumatic Tools.—The Independent Pneumatic Tool Company, Chicago, has issued a new catalog, No. 9, 118 pages, relating to the Thor pneumatic tools, including air drills; reaming, tapping and wood boring machines; grinders, riveters and chipping, calking and beading hammers. It also includes pneumatic staybolt drivers, hoists, motors and tube expanders. All these are illustrated by excellent drawings of the complete tools and general views showing their application in building and repairing locomotives and cars. There are complete catalogs of repair parts which are each illustrated and numbered. The Corliss valve motion used in the drills and one-piece riveting hammers, and the valve mechanism in chipping and calking hammers are claimed to be the latest and most scientific improvements in air tools. Since the last catalog was published a number of improvements have been made in these tools, the most important of which is the adoption of roller bearings and a one-piece connecting rod in all drills. The tabular specifications tor Thor air tools include, in addition to general dimensions, the weight, the amount of air required for driving in cubic feet per minute, speed and capacity.